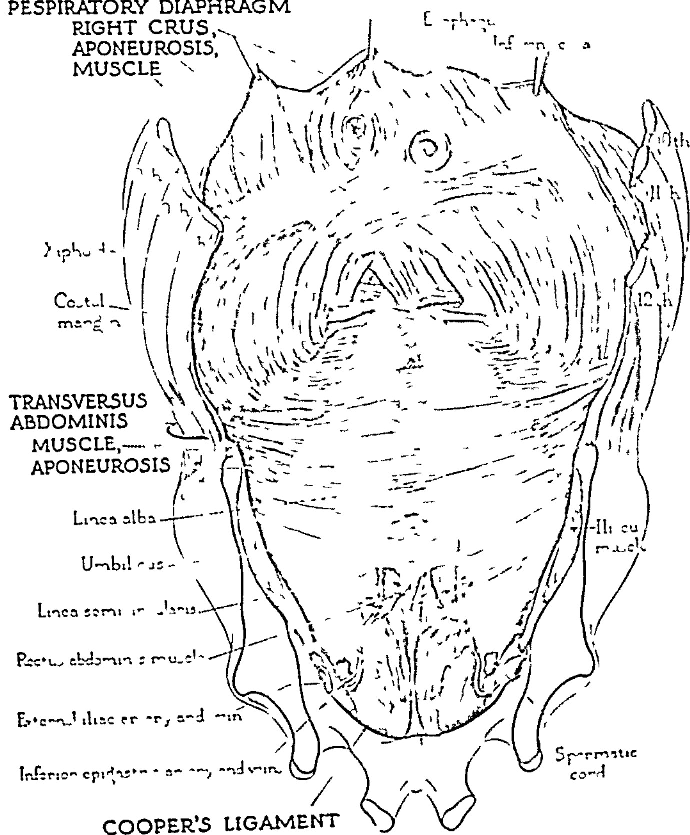


PLATE I. *Frontispiece.* [illegible] view of the [illegible] wall and the [illegible] [illegible] connective tissue and the [illegible] removed [illegible]. This layer is the key to the [illegible] [illegible] of all [illegible] hernias [illegible] have first [illegible] in any procedure [illegible] hernia

HERNIA

The Pathologic Anatomy of the More Common Hernias and Their Anatomic Repair

By

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Introduction

It is not intended that this atlas should be comprehensive but rather that the text be brief and tied intimately to the illustrations so that the text for the figures will always be either on the same or the opposite page There are a number of excellent texts on hernia some of them encyclopedic in scope that cover the sub ject in detail including variations in type of a given hernia and a host of different surgical techniques Nowhere in the field of surgery is there such a multiplicity of operations for a given anatomic defect this not only reflects basic misunderstanding of the problem involved but is most confusing to the young surgeon

The purpose of this atlas is to present the common types of hernia in simple form stress ing the anatomic defect either congenital or acquired and to present the methods preferred by the author for surgically correcting these de fects in anatomic structure The external ap pearance of hernias of the abdominal wall and the management of the peritoneal sac have not been emphasized except for the appearance of incisional hernias and the management of the sliding type of hernia likewise the diagnosis and the differential diagnosis of the various her nias will not be discussed Occasional pictorial reference will be made to the skin incision but in general this author believes that all skin in cisions should be in the lines of skin cleavage irrespective of their location The final closure of the wound is omitted as noncontributory to this atlas and while no specific discussion of suture material will be presented non absorb-able suture of the smallest caliber commensurate with good surgical repair is the authors prefer ence

A constant pattern has been adopted for the presentation of each type of hernia First an anatomically accurate view is shown of the musculoaponeurotic defect stressing the basic alterations of normal anatomy that permit the hernia to develop and second the successive major steps in the surgical correction of this anatomic defect are presented In every in stance the anatomic defect has been prepared from a cadaver dissection of the hernia so that the alteration in the musculoaponeurotic struc-ture will be accurate in every detail The ana-tomic plate in each type of hernia is a posterior view of the anterior abdominal wall in the re-gion of herniation and although this will be an unfamiliar approach to the problem for many surgeons the author hopes to impress upon his readers the importance of the innermost of the musculoaponeurotic layers the transversus abdominis The more superficial internal ob-lique and external oblique layers are only of secondary importance for once a hernia has penetrated the transversus abdominis layer a hernia exists and the oblique musculoaponeu rotic laminae only serve to modify or direct the course of the developing hernia Noncontribu tory structures such as peritoneum preperito neal fat and fascia and in some instances mus cular fascia have been removed so that the fundamental musculoaponeurotic defect may be clearly seen

The surgical repair was first performed upon the cadaver so that anatomic detail would be accurate and then modified where necessary to conform to the surgeons view at the operating table It has been the authors teaching experi ence that not only is it frequently difficult to transpose the anatomy from the dissecting table to the operating table because of a difference in perspective but also that a surgeon who re pairs hernias is not *ipso facto* an anatomist It is a curious incongruity that most of our recent generation of surgeons are only haphazard anat omists this is due in part to a decreasing em phasis on gross anatomy in our medical schools in the past three decades and in part due to the increasing emphasis on the more dramatic albeit important basic sciences in our gradu ate training programs In many branches of surgery this is of no serious consequence but a hernia is an anatomic derangement and to un

derstand the cause and especially the repair of a hernia a detailed knowledge of the anatomy of the layers involved is absolutely essential To attempt the repair of hernias without intimate and detailed knowledge of the anatomy of the egion is to invite a formidable recurrence rate One has only to review the many methods of epairing an inguinal hernia to realize that omething is very radically amiss otherwise here would have been no necessity for such a nultiplicity of operations in so small an area

It is recognized by the author that there are nany "accepted" methods of repairing a given ernia and concerning inguinal and femoral hernias the methods are legion however, in this atlas only one method is presented for each type of hernia and it is obviously the author s preference To avoid encumbering this simple atlas with multiple references to the literature bibliographic references, including the author s own contributions will be omitted

The excellence of any atlas is dependent upon the quality and accuracy of the illustra tions In this instance I am especially indebted to Mrs Lucille Cassell Innes whose excellence of illustration is obvious and for her suggestions concerning surgical perspective which should help to clarify the many problems encountered in teaching the surgical repair of hernias I also wish to express my deep appreciation to two men who have profoundly influenced me as an anatomist and as a surgeon Barry J Anson Professor of Anatomy, Northwestern University Medical School and Frederick A Coller Professor of Surgery, University of Michigan Medical School

C B McV

Preface

THE HERNIA PROBLEM IN GENERAL

To UNDERSTAND the fundamental defect in any hernia it is absolutely necessary for the surgeon to know the basic anatomy of the region involved and yet it is frequently apparent at the operating table that the surgeon has only the vaguest idea of the anatomy of the region in which he is working Because the transversus abdominis layer is all important and because one sees only isolated areas of it in the conventional anterior cadaver dissections the *Frontispiece* is presented to show the extent and conformation of the transversus abdominis muscle and aponeurosis this can only be accomplished in a posterior view of the abdominal wall It should be an obvious fact that when the innermost musculoaponeurotic layer is perforated a hernia exists and conversely if the transversus abdominis muscle and aponeurosis with its attached transversalis fascia remains intact that a hernia of the abdominal wall is impossible All too frequently in the conventional anterior approach the strategic importance of the transversus abdominis layer is not realized by the surgeon because his attention is consumed by the more obvious and superficial musculoaponeurotic laminae As the first step in the hernioplasty the surgeon should so plan his operation that the anatomic structure of the transversus abdominis is returned to normal

It should be further understood that the respiratory diaphragm and the pelvic diaphragm form an integral part of this same layer although named differently Also the transversalis fascia the infradiaphragmatic fascia and the superior fascia of the pelvic diaphragm are all the same fascial plane with regionally different names The endopelvic fascia is simply the transversalis fascial layer turned upward upon the viscera that perforate the pelvic diaphragm an analogous situation exists where the esophagus perforates the respiratory diaphragm

The word fascia is so loosely used in surgical parlance that it seems pertinent to define a fascia and especially to differentiate a fascia from an aponeurosis A fascia is a layer of areolar fibers and the fasciae are disposed as sheets of tissue throughout the body where they invest muscles neurovascular bundles and parenchymatous organs There is no organized arrangement of the fibers and regionally the fasciae are modified by the demands of the body varying greatly in thickness and in their content of fat In places they may even contain smooth muscle fibers or elastic fibers and in places a fascial plane may be converted into an aponeurotic lamina by virtue of muscular origin or insertion e g the intermuscular septa of the thigh or the so-called lumbodorsal fascia In the embalmed cadaver they may appear to be tough, resistant membranes but in the living subject they have very little tensile strength unless reinforced by aponeurotic fibers An aponeurosis on the other hand is a flattened tendon with collagenous fibers disposed in organized bundles its tensile strength is great and directly proportional to the number of fibers per unit area The aponeurosis (tendon) of a muscle has as many fibers as the muscle has muscle fibers In the abdominal wall the resistance to herniation is dependent upon the strength and disposition of the musculoaponeurotic fibers and not upon the fasciae The rectus sheath so commonly referred to as a fascia is a complex interdigitation of aponeurotic fibers of insertion of the three anterolateral abdominal muscles and not a fascia although these aponeurotic plates are invested by fasciae

Whereas the transversalis fascia is routinely mentioned in hernia discussions it should be pointed out that the transversalis fascia alone is a layer of extremely variable thickness and with very little intrinsic tensile strength By definition the transversalis fascia is simply a muscle fascia investing the inner or abdominal

aspect of the transversus abdominis muscle and aponeurosis and differs *in no special way from* any other muscle fascia In *some slender*, athletic individuals especially in the inguinal region and especially in the cadaveric state the preperitoneal connective tissue may be almost totally devoid of fat and appear as a substantial fascial plane It is undoubtedly this characteristic of the preperitoneal connective tissue in the inguinal region that has led to the confusion in nomenclature, the important point, however, is that this layer is worthless in the repair of hernias

In the *Frontispiece* the transversalis fascia has been removed to show in detail the muscular and aponeurotic fibers of the transversus abdominis and the respiratory diaphragm Acquired hernias, incisional hernias excepted represent a separation of these fibers and surgical correction of the hernia should take into consideration the lines of contraction of the muscle fibers i e, the line of closure should carefully parallel the direction of the musculoaponeurotic fibers and not be at right angles or an oblique angle to these fibers If this principle is violated muscle pull will tend to cause a dehiscence of the wound *Furthermore sutures tend to* pull out from between the cut ends of the aponeurotic fibers when the line of closure is perpendicular to these fibers the investing fasciae and the variable decussation of the aponeurotic fibers are the only features that prevent this from happening routinely Further any abdominal incision that accomplishes closure across the lines of muscle pull and relies upon the healing scar to withstand this muscle pull is potentially a candidate for the development of an incisional hernia because eventually the scar will stretch and attenuate The advocates of the routine use of the vertical abdominal incision cannot be fully cognizant of this view of the abdominal wall or the structural composition of the rectus sheath

In considering this posterior view of the abdominal wall and before the hernias are considered individually it is well to realize that traumatic diaphragmatic hernia epigastric hernia semilunar (Spigelian) hernia direct inguinal hernia and lumbar hernia are due to the acquired protrusion of parietal peritoneum through and between the musculoaponeurotic fibers Esophageal hiatus hernia umbilical hernia indirect inguinal hernia, femoral hernia and obturator hernia are due to a congenital defect in the musculoaponeurotic apparatus As this latter group of hernias enlarge they displace musculoaponeurotic fibers in the same manner as the first group so that their surgical repair presents an identical problem In general then, after disposal of the hernial sac, the hernial defect should be closed along lines that parallel the musculoaponeurotic fibers of the layers concerned Small incisional hernias can be repaired according to this principle by dissecting out the individual layers but large incisional hernias in a vertical incision defy anatomic repair In this type of hernia there is actual retraction of cut aponeurotic fibers with a fixed contracture of the corresponding muscle fibers The defect is too large for redevelopment of the layers with an anatomic closure and even when the margins of the vertical defect can be approximated it is always under extreme tension and the same muscular pull that caused the hernia in the first place will continue to act and attempt to separate the closure Aponeurotic ("fascial") grafts aponeurotic suture material and more recently the addition of wire mesh are at best only a makeshift in an attempt to solve a problem to which there *is no wholly* satisfactory solution

The only possible solution to the large incisional hernia problem is prophylactic in that if the vertical rectus incision were abandoned there would be no serious difficulty in repairing the incisional hernias that occur in transverse incisions Although the small truely muscle and aponeurosis splitting incision that is used for appendectomy cannot be used for the more major abdominal operations because of inadequate exposure the long transverse incision incises a minimal number of musculoaponeurotic fibers as compared to the vertical incision which incises all of the fibers for the length of the incision An important feature of the long transverse incision if properly made is that none of the musculoaponeurotic fibers of the transversus abdominis layer are severed and this is the

most important of the three anterolateral abdominal musculoaponeurotic plates in the prevention of incisional herniation One or both rectus abdominis muscles may be sectioned with impunity The transversus abdominis pull is directly transverse in the mid abdomen and the resultant of the actions of the external oblique and internal oblique muscles is also transverse so that an incisional hernia in a transverse incision never offers a very wide defect to be approximated and it can be accomplished in layers without excessive tension

The use of the inguinal ligament as the anchoring structure in inguinal and femoral hernioplasty has no factual anatomic basis and so will not be presented in this atlas Although some surgeons will consider this a serious omission the technique of inguinal ligament hernia repair is so readily available elsewhere that the author feels no obligation to present an operation that he feels is anatomically unsound

C B McV

Contents

INTRODUCTION vii

PREFACE—THE HERNIA PROBLEM IN GENERAL ix

DIAPHRAGMATIC HERNIA 3
- Esophageal Hiatus Hernia 3
- Traumatic Diaphragmatic Hernia 5

EPIGASTRIC HERNIA 7

UMBILICAL HERNIA 11
- Small Umbilical Hernia of Infancy 11
- Large Umbilical Hernia 11

HERNIAS OF THE INGUINAL AND FEMORAL REGION 15
- Small Indirect Inguinal Hernia 19
- Medium Indirect Inguinal Hernia 21
- Large Indirect Inguinal Hernia 23
- Direct Inguinal Hernia 25
- Femoral Hernia 29

INCISIONAL HERNIA 33

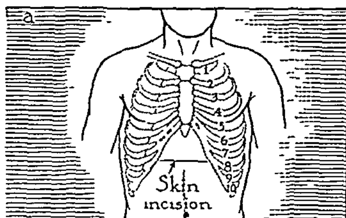
LUMBAR AND PELVIC HERNIAS 39

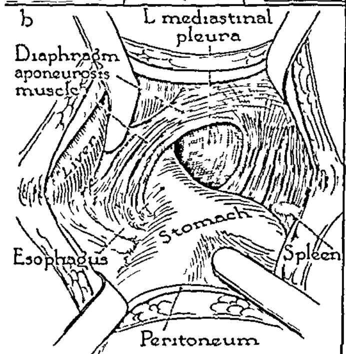
List of Plates

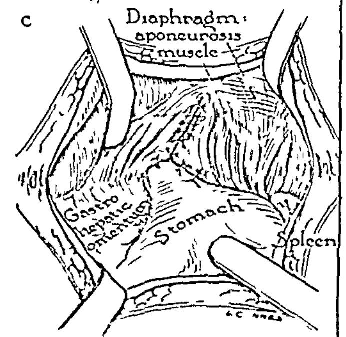
Page

Plate I Respiratory Diaphragm — Frontispiece
Plate II Esophageal Hiatus Hernia — 2
Plate III Traumatic Diaphragmatic Hernia — 4
Plate IV Epigastric Hernia — 6
Plate V Epigastric Hernia — 8
Plate VI Small Umbilical Hernia — 10
Plate VII Large Umbilical Hernia — 12
Plate VIII Hernia in the Linea Semilunaris (Spiegel's Hernia) — 14
Plate IX The Anatomy of the Inguinofemoral Region — 16
Plate X Small Indirect Inguinal Hernia — 18
Plate XI Medium Indirect Inguinal Hernia (Female) — 20
Plate XII Large Indirect Inguinal Hernia — 22
Plate XIII Sliding Hernia — 24
Plate XIV Direct Inguinal Hernia — 26
Plate XV Femoral Hernia — 30
Plate XVI Small Incisional Hernia — 32
Plate XVII Large Incisional Hernia — 34
Plate XVIII Large Incisional Hernia — 35
Plate XIX Lumbar and Pelvic Hernias — 39

HERNIA







DIAPHRAGMATIC HERNIA

Plate II Esophageal Hiatus Hernia

a The incision is transversely placed in the epigastrium at the level of the 8th costal cartilages The anterior rectus sheath is incised for the length of the skin incision and the rectus muscles transected ligating the main branches of the superior epigastric vessels with suture ligatures The fibers of the posterior rectus sheath and the linea alba are then separated and the peritoneal cavity entered on either side of the round and falciform ligaments of the liver which are then cut between suture ligatures This incision is also used for all types of gastric surgery and abdominal vagotomy and is therefore frequently used It is the incision of choice for anatomic reasons (see *Frontispiece Preface* and section on *Incisional Hernias*)

b Exposure of the enlarged esophageal hiatus The triangular ligament of the left lobe of the liver has been cut and the lobe retracted to the patients right under pack and retractor All packs are omitted from the figure for clarity The hernia has been reduced and the margins of the hiatus delineated The diaphragmatic peritoneum has been removed in the figure to demonstrate the musculoaponeurotic fibers of the diaphragm. Care must be exercised to avoid tearing the left mediastinal pleura or lacerating the spleen with retractors or by undue traction upon the stomach.

c. The Hernia Repair. (Closure of the enlarged esophageal hiatus) The defect has been closed with interrupted medium silk sutures in a direction parallel with the musculoaponeurotic fibers of the diaphragm, pushing the esophagus posteriorly between the crura of the diaphragm A proper closure of the esophageal hiatus is considered a snug fit for the esophagus and the surgeons index finger The abdominal esophagus and adjacent fundus of the stomach are sutured circumferentially to the margin of the reconstructed hiatus to prevent sliding with motion of the diaphragm and leaving the foundation for the recurrence of the hernia. The viscera are allowed to resume their respective positions the spleen inspected for bleeding and the abdominal wound closed without drainage

Diaphragmatic Hernia

Esophageal Hiatus Hernia

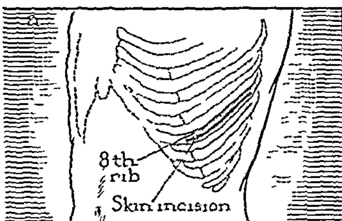
While either the abdominal or the thoracic approach may be used for the repair of an esophageal hiatus hernia the author uses the abdominal approach in most instances However if the hernia is unusually large and the history suggests long duration or if roentgenographic examination suggests ulceration or carcinoma the thoracic approach is used The abdominal approach is through a transverse intercostal incision (Fig a) and although the level of the incision varies slightly depending upon the width of the subcostal angle it is usually located between the 8th costal cartilages In the patient with a narrow subcostal angle exposure is more readily obtained through a left vertical rectus incision extending up into the angle between the left costal margin and the base of the xyphoid process Although this incision should probably be used by the surgeon who is unfamiliar with the operation the author never uses a vertical incision in the upper abdomen because the incidence of incisional herniation in the vertical incision in this location is too high The substitution of an incisional hernia for an esophageal hiatus hernia is a poor exchange Occasionally the author has had difficulty in reducing and repairing this hernia through the transverse intercostal incision but the fault was not in the incision but in the fact that the thoracic approach should have been used When the surgeon discovers that the hernia cannot be safely reduced by the abdominal approach the transverse intercostal incision at the level of the 8th costal cartilage lends itself well for extension into the left 8th intercostal space and a combined thoracoabdominal operation This is not the case when the vertical incision is used

After the incision is made as illustrated and described (Fig a) the secret of performing the operation with facility is in the exposure (Fig b) While this platitude is true of any operation it is especially true when one is working at the bottom of a deep hole as is always the case in the abdominal approach to the esophageal hiatus Good surgical anesthesia is an absolute necessity and as in most major surgical procedures intratracheal ether oxygen is our anesthetic of choice If the left mediastinal pleura is accidentally torn or if the abdominal incision is extended into the thorax the patient and the anesthetist are ready without delay or difficulty The vicinity of the hernia is provisionally exposed with pack and ribbon retractor on the stomach and the triangular ligament of the left lobe of the liver is incised back to the bare area The left lobe of the liver is then folded back upon itself covered with a pack and retracted There is such variation in the shape of the left lobe of the liver that it cannot always be retracted in the same way but manipulation with the hand will demonstrate the best maneuver as a rule the lateral edge of the left lobe is turned posteriorly and to the patient s right The peritoneal reflection from stomach to diaphragm is incised and then by blunt dissection with the finger and traction on the stomach the hernia is usually reduced with ease and the enlarged esophageal hiatus exposed A penrose drain placed around the esophagus and used for traction is helpful Before establishing forceful traction or retraction upon the stomach the size position and fixation of the spleen should be carefully determined If it is fixed to the diaphragm by adhesions it should be freed or manipulated in the retraction very gently A lacerated spleen or an avulsed segment of capsule necessitates splenectomy to control bleeding and while this is a simple procedure it is an unnecessary addition to the operation of esophageal hiatus hernioplasty The real danger is not recognizing a lacerated spleen and to avoid this catastrophe the spleen should be carefully inspected again for injury as the last procedure before wound closure

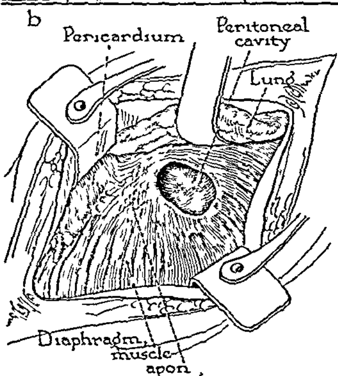
After adequate exposure and reduction of the hernia the margins of the defect are trimmed of fragments of peritoneum and fascia so that the

DIAPHRAGMATIC HERNIA

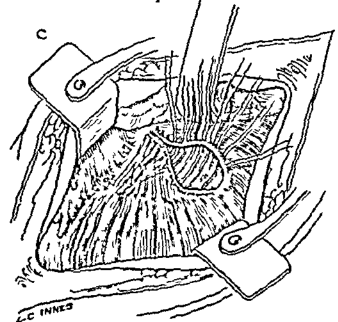
Plate III Traumatic Diaphragmatic Hernia



a. Schematic view of the left lateral chest wall to indicate the incision for the repair of a hernia through the left leaf of the diaphragm The skin incision parallels the 8th rib extends from the costochondral junction to the posterior axillary line and is carried down to the periosteum of the rib, separating the fibers of the pectoralis major and the serratus anterior muscles The 8th rib is then removed subperiosteally for the length of the incision and the pleural space entered through the rib bed. This gives excellent exposure and the wound is more easily closed than when an intercostal incision is used. The operation is performed with the patient in the supine position with the left upper extremity secured to the overhead operating table frame.



b Transthoracic exposure of the hernial defect in the left leaf of the diaphragm. The abdominal viscera have been separated from the thoracic viscera and reduced into the abdominal cavity The attenuated aponeuroticofascial margins of the hernial defect have been excised along with tags of diaphragmatic peritoneum and pleura to reveal the actual aponeurotic margins of the hernial defect. The diaphragmatic pleura is removed in this figure to illustrate the direction of the musculoaponeurotic fibers of the respiratory diaphragm which the surgeon must understand for the correct closure of the defect. Invariably the long axis of the defect will be in the direction of the musculoaponeurotic fibers of the diaphragm and the closure must parallel these fibers to accomplish closure without tension.



c. The Hernia Repair. Three of the mattress sutures are tied and the remainder are in place ready to be tied. The mattress sutures of 00 silk or nylon evert the edges of the hernial defect on the pleural side and they are placed closely enough to prevent pieces of omentum from protruding through into the pleural space in the postoperative period. In a defect of this size the phrenic nerve is not crushed but in larger defects it is crushed just above the diaphragm as it still lies between the mediastinal pleura and the pericardium. This is usually done after the abdominal viscera have been reduced but before the repair is started. The chest wall is closed in layers with interrupted 00 silk mattress sutures for the intercostal musculofascial layer after severing the 8th intercostal nerve at the posterior angle of the incision. The fasciae of the pectoralis major and serratus anterior muscles, the subcutaneous fascia and skin are all closed with interrupted fine silk sutures The pleural space is drained through a stab wound in the 10th intercostal interspace posterolaterally by a catheter that is connected to an underwater seal bottle. The general principles of an open chest operation are observed throughout the procedure, especially the expansion of atelectatic lung compressed by the hernia

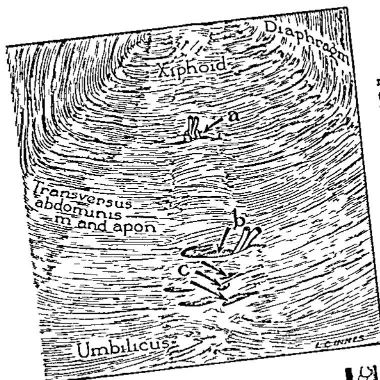
musculoaponeurotic fibers of the diaphragm are used in the repair and not the thinned out fascia The usual position of the defect as related to the esophagus is as shown (Fig b) but it may be medial or posterior to the esophagus In any event the esophagus should be pushed posteriorly between the crura of the diaphragm and the enlarged hiatus closed anterior to the esophagus (Fig c) The line of closure should carefully parallel the direction of the fibers of the diaphragm for a closure without tension Interrupted medium silk or nylon sutures are used and the hiatus snugly closed To prevent sliding of the esophagus the margin of the reconstructed hiatus is sutured to the serosa of the fundus of the stomach at the cardia with the same suture material Occasionally the presence of a congenitally short esophagus makes this type of procedure unsatisfactory in which event the procedure of choice is probably to transpose the upper end of the stomach into the posterior mediastinum and suture the margins of the hiatus circumferentially to the stomach Recurrence of a hiatus hernia following adequate repair suggests that a short esophagus was unrecognized at the time of the original operation

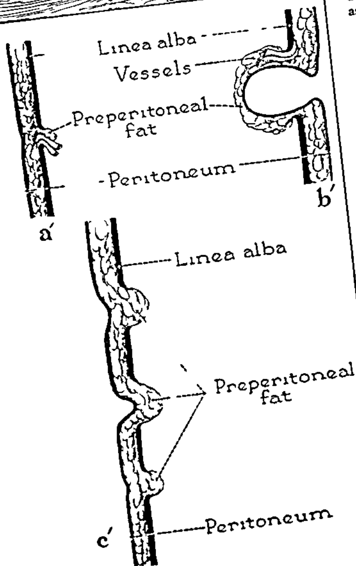
Traumatic Diaphragmatic Hernia

The thoracic approach is always used in this type of hernia because the herniated abdominal viscera are invariably densely adherent to the thoracic viscera and pleura The blind reduction of the abdominal viscera by traction in the abdominal approach is extremely hazardous or even impossible Even with the chest open and the herniated abdominal viscera under good direct vision their separation from the thoracic viscera can be a time consuming and assiduous job When the hernia is of long standing the adhesions are dense and the planes of cleavage may be ill defined. Even though the hernia could be safely and easily reduced by the abdominal approach the technical aspects of the repair of the defect in the diaphragm are much simpler by the transpleural route

The preoperative preparation and postoperative care of these patients follow sound surgical principles which will not be discussed except to say that even in the uncomplicated and unobstructed case, gastric suction is established before the operation is started and maintained in the postoperative period until normal bowel sounds appear If there is any degree of intestinal obstruction a long tube is passed well down into the small intestine preoperatively Decompression of the small intestine not only facilitates the reduction of the abdominal viscera and repair of the hernia but makes for a smoother convalescence as in any case of partial intestinal obstruction The supine position on the operating table and good positive pressure intratracheal anesthesia make the transpleural exposure of this hernia (Fig a) a safe and simple procedure

Most traumatic hernias of the diaphragm will not have a peritoneal sac and so the abdominal viscera are immediately encountered The parietal pleura should be opened with the same caution that the peritoneum is opened as colon or stomach may be adherent to the parietal pleura at the site of incision After careful inspection of the herniated abdominal viscera they are freed and reduced into the abdominal cavity enlarging the hiatus in the direction of the musculoaponeurotic fibers if necessary Should a segment of bowel be devital and resection indicated this can be done readily through the thoracic approach by enlarging the diaphragmatic defect and is not an indication for the abdominal route as advocated by some authors The average defect such as illustrated (Fig b) is closed as shown (Fig c) crushing the phrenic nerve when necessary to gain a closure without tension Larger defects that cannot be approximated present a problem that will tax the ingenuity of the most skilled surgeon and are hardly the province of this atlas However the surgeon faced with this dilemma should realize that he must either borrow tissue which can be done by cutting the costal attachment of the diaphragm and advancing it superiorly to make a flat transverse diaphragm or decrease the size of the thoracic cage on that side and this can be done by lower rib thoracoplasty A strong surgeon and strong suture material are not a substitute for inadequate diaphragmatic muscle and aponeurosis





EPIGASTRIC HERNIA

Plhte IV

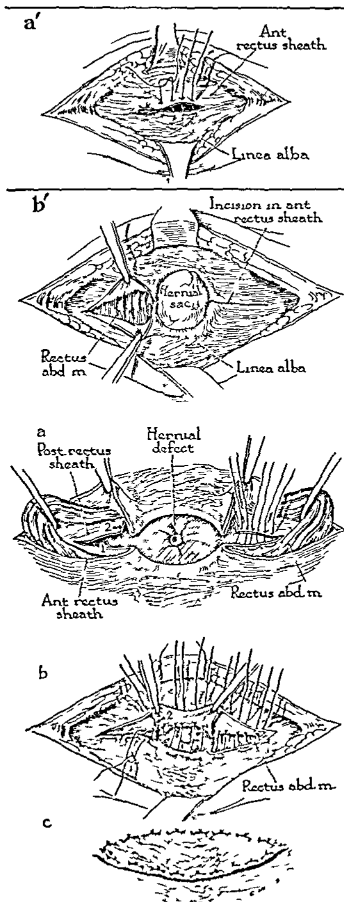
Posterior view of the abdominal wall in the epigastric region with the peritoneum and preperitoneal connective tissue removed to demonstrate three types of epigastric hernia Perforating blood vessels are common in this area of the linea alba and one frequently observes a small lobule of preperitoneal fat, without a peritoneal sac protruding through a vessel aperture as at (a) and shown below in sagittal section at (a^1) The fat is incarcerated, usually painful and the hernia requires surgical correction At (b) is a large epigastric defect which contains a fully devel oped hernial sac as shown in sagittal section at (b^1) An epigastric hernia such as shown at (b) and (b^1) undoubt edly begins in the manner shown at (a) and (a^1) with gradually more and more preperitoneal fat pushing through the small defect enlarging it and eventually pulling the parietal peritoneum through the aperture too Occasionally one sees a cluster of apertures through the linea alba as seen at (c) and the three defects indicated by the arrows are seen in sagittal section at (c^1) Multiple apertures such as these are converted into a single larger defect and handled as a large epigastric hernia such as at (b)

Epigastric Hernia

ONLY HERNIAS of the linea alba between xyphoid and umbilicus will be included under this heading Rarely epigastric hernias occur lateral to the rectus muscles in the linea semilunaris but since most surgeons will never see such a hernia in the epigastrium only one type of linea semilunaris hernia will be presented and that under the heading of Spiegel s hernia hereinafter In general these hernias are small and although they may occur anywhere in the linea alba between xyphoid and umbilicus they are most common immediately above the umbilicus The larger variety of epigastric hernia is invariably in the supraumbilical region While these hernias must be considered as acquired from an etiologic point of view there is certainly a congenital predisposition or anatomic fault that permits them to develop which was well recognized by the early anatomists All epigastric hernias begin as small protrusions of preperitoneal fat between the decussating aponeurotic fibers of the linea alba and in most instances the initial defect is certainly the aperture for a perforating blood vessel [at (a) and (b) in the figure on opposite page] These perforating blood vessels are seen routinely in cadaver dissections and at the operating table unassociated with a hernia but it is also true that perforating blood vessels invariably accompany the fat of even the smallest epigastric hernia and must be ligated to avoid bleeding in the extraperitoneal space While there is a paucity of fat in the preperitoneal layer in the upper abdomen it is always abundant between the layers of the falciform ligament of the liver which lies behind the linea alba and it is this fat that protrudes in epigastric hernias In elderly patients one occasionally sees clustered epigastric herniations which are apparently due to attenuation of the aponeurotic fibers of the linea alba with multiple lobules of fat presenting through the interstices of the linea alba Typical examples of epigastric herniation are presented on the facing page and when a cluster of protrusions occur (c and c[1]), they are converted into a single defect for repair

Small epigastric hernias containing only a protrusion of preperitoneal fat (a and a[1]) present a simple problem for repair but they may be difficult to detect especially in the obese patient They are regularly incarcerated and painful, and unless discovered the patient s symptoms are usually ascribed to duodenal ulcer or gall bladder disease Sharply localized tenderness in the contracted abdominal wall not aggravated by deep palpation with the musculature relaxed is a useful differential diagnostic aid The repair of these small defects is simple and consists of exposing the herniated lobule of fat through a small transverse incision over the mass If it is pedunculated it is excised after ligating the base with a suture ligature because of the blood vessels that invariably accompany the fat If it is sessile it is simply reduced The aponeurotic defect is always enlarged laterally on either side to facilitate reduction and for adequate inspection to rule out a peritoneal component of the hernia After the fat is reduced the margins of the aponeurotic defect are approximated in a transverse direction with interrupted mattress sutures (Fig a[1] next page) The author prefers 32 gauge stainless steel wire sutures not only for this small type of epigastric hernia but for all epigastric and umbilical hernias These hernias should never be closed in the vertical plane because the contraction of the abdominal musculature will tend to separate the closure whereas a transverse closure is under no tension even with violent contraction of the muscles [*Frontispiece* Fig (a) opposite and Fig (a[1]) next page] When the linea alba is very broad as in diastasis recti even a moderate sized epigastric defect can be repaired by simple transverse closure or a limited "vest over pants" closure usually referred to as the Mayo operation In the larger defects closure cannot be accomplished by this simple

Plate V Epigastric Hernia



a[1] The hernia repair of a small epigastric defect as shown at (a) and (a[1]) in the figures on the preceding page The blood vessels are ligated and the protruding lobule of fat either reduced, or excised after ligation of the neck. The slit like defect is simply closed with interrupted mattress sutures that evert the edges

b[1] An incarcerated epigastric hernia such as shown in (b) and (b[1]) in the figures on the preceding page. The tightly constricting ring of the aponeurotic defect in the linea alba is cut laterally on each side and the incision ex tended laterally as shown. This permits easy reduction of the hernial contents after opening the sac to ascertain their viability The peritoneal sac is then disposed of in the con ventional manner

a The hernia repair. The peritoneal sac has been ligated and the rectus muscle on either side retracted laterally in the incision through the anterior sheath. The posterior rectus sheath is then incised transversely on either side as shown at (1) on the left side of the figure The superior flap of the posterior rectus sheath is then incised vertically on either side immediately adjacent to the linea alba as shown at (2) The transverse incision in the pos terior rectus sheath on either side is then closed with mat tress sutures so as to shorten the vertical length of the posterior sheath in the area of the hernia repair On the right side of the figure the sutures are in place and after suturing the transverse incision on the left side in a simi lar manner the retracted rectus muscles are allowed to resume their original position. The device of cutting the posterior rectus sheath as demonstrated at the numbers (1) and (2) has been adopted by the author to gain mo bility of the superior flap for an overlapping closure of the aponeurotic defect. In a hernia of this size the aponeu rotic defect is too large and the margins too rigid to permit satisfactory closure as illustrated in figure (a) above

b The hernia repair continued The first layer of mattress sutures are placed for the overlapping or "vest over pants" closure of the defect Two of the sutures are tied on the left hand side of the figure and in between the tied mattress sutures is a tied single interrupted suture Another interrupted suture is in place but not tied. These are placed in between the mattress sutures to insure com plete closure It now becomes apparent that the incision (2) in the above figure has permitted mobilization of the superior flap in a smooth line for overlapping. The cut edge of the posterior rectus sheath adjacent to the linea alba is labeled with the number (2) in this figure All of the first layer of mattress sutures are then tied and inter rupted single loop sutures placed between the mattress sutures

c. The hernia repair completed The free edge of the superior flap is now sutured in place with a series of mattress sutures which completes the hernia repair The subcutaneous fascia and skin are closed in the usual manner

method without considerable tension and a more extensive operation is necessary

Fully developed epigastric hernias with a peritoneal sac are also exposed through a transverse incision over the mass and the aponeurosis of the linea alba and the surrounding anterior rectus sheath are exposed for a sufficient area about the hernia to accomplish an overlapping closure without having fat on the flaps It is in cleaning the sheath and the linea alba about the hernia that the small perforating blood vessels referred to above are always encountered The neck of the sac and the hernial ring are clearly delineated by sharp dissection but before the sac is opened the aponeurotic defect is enlarged laterally on either side well into each rectus sheath (Fig b[1]) This is done for two reasons first because adequate dissection and ligation of the peritoneal sac cannot be accomplished through the rigid and constricting aponeurotic hernial ring and second because it is impossible to satisfactorily repair the hernia by simple closure of the rigid margins of the defect in the linea alba After the anterior rectus sheath is incised on either side (Fig b[1]) the rectus muscles are retracted laterally and the posterior rectus sheath incised laterally (Fig a, 1) The peritoneum is then freed up from the margins of the hernial ring and from the under surface of the linea alba and posterior rectus sheath by a combination of sharp and blunt dissection The freeing up of the peritoneum and the closure of the peritoneal sac (Fig a) are by conventional methods but the uninitiated should be warned that the peritoneum in this location is extremely thin and friable

After disposing of the hernial sac the hernia is repaired as illustrated (Figs a b and c) and described in the accompanying legends The transverse incisions in the posterior rectus sheath (Fig a) serve a dual purpose first they allow adequate treatment of the peritoneal sac, and second, they facilitate the first stage in the repair of the hernia To the reader who may not have been faced with the repair of one of these large defects the problem may not be exactly clear but unless one manages the incisions (Fig a 1 and 2) as described in the legend a difficult situation presents itself If just the anterior sheath is used an insecure closure results in the linea alba because of the rigidity of the hernial aperture If one attempts an overlapping closure an awkward arrangement exists which can be visualized (Fig a) if the point on the leader from the label Post rectus sheath" is brought down to the point on the leader from the label Ant rectus sheath" Not only is this an unanatomic exchange of layers with the rectus muscles dislocated from their normal line of pull but it still does not give adequate relaxation for a secure closure of the linea alba To circumvent this problem and gain an adequate closure without tension the author uses the device as shown (Figs a b and c) The transverse incisions in the posterior rectus sheaths originally made for exposure are closed with mattress sutures so as to foreshorten the posterior sheath (right side of Fig a) The vertical incisions in the posterior rectus sheath immediately next to the linea alba (Fig a 2) gain mobility for the superior flap of the linea alba and then the linea alba and the anterior rectus sheath on either side can be used as a single layer (Fig b) and brought down over the inferior flap without undue tension for a double layer closure (Fig c)

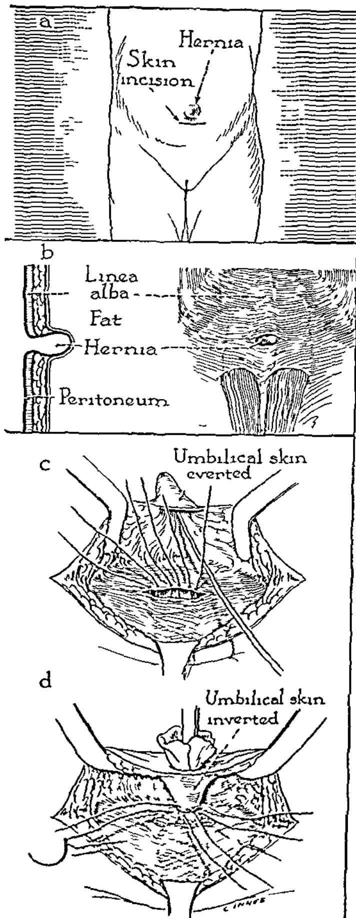


Plate VI Small Umbilical Hernia

a The skin incision is transversely placed either just above or just below the everted umbilical skin in this instance just below It is transverse in direction to follow the lines of skin cleavage for the best cosmetic result and the umbilical skin is never removed The incision is carried down through the subcutaneous fascia to the linea alba and the skin flaps developed for exposure of the hernial defect The superior skin flap with the umbilical skin is carefully dissected off of the hernial sac to avoid button holing the skin The peritoneal sac is opened the contents reduced the neck of the sac freed from the margins of the defect in the linea alba ligated and the excess peritoneum excised

b On the left is a midline saggital section through the hernial defect to demonstrate several features of this type of hernia In the immediate area around the umbilicus there is an almost total absence of fat between the peritoneum and the aponeurotic linea alba which makes the delineation of the neck of the peritoneal sac a delicate procedure if one is to avoid tearing holes in the peritoneum beyond where they can be repaired While there is abundant fat about the base of the hernial sac in the subcutaneous layer only a little areolar tissue separates the everted umbilical skin from the peritoneum of the hernial sac and again it must be carefully separated to avoid button holing the skin.

On the right, is a posterior view of the abdominal wall with the peritoneum and preperitoneal connective tissue removed to demonstrate the aponeurotic defect of the small umbilical hernia In this small type of hernia it should be noted that the defect is entirely within the linea alba and does not extend into the rectus sheath on either side It is also evident in this view why the defect should be closed transversely rather than vertically The margins come together without tension in the transverse plane and the contraction of the transversus abdominis and oblique muscles will not tend to distract the closure as would be the case if the defect were closed in the vertical plane

c. The hernia repair The peritoneal sac has been ligated at its base and the excess excised The mattress sutures of fine silk or stainless steel wire are placed ready to be tied. The everted umbilical skin in the superior skin flap is demonstrated by a probe

d The repair continued The mattress sutures in the linea alba have been tied everting the edges. The apex of the umbilical skin is sutured to the linea alba adjacent to the closure of the hernial ring with three interrupted fine silk sutures The subcutaneous fascia is closed in layers with fine silk sutures so as to obliterate the dead space about the umbilicus After the skin is sutured and before the dressing is applied the umbilical dimple is packed with fine mesh gauze or when the Halsted silver foil is used as the wound dressing the paper is wadded up and packed into the umbilical dimple This serves to fashion a normal appearing and open umbilicus

Umbilical Hernia

TWO EXAMPLES of umbilical hernia are pre sented First the small congenital umbilical hernia of infancy and second the larger acquired umbilical hernia of adulthood Om phalocele or hernia into the umbilical cord is a difficult surgical problem for which no single procedure can be presented and is omitted from this atlas

SMALL UMBILICAL HERNIA OF INFANCY

Most of these hernias which become appar ent in the first few weeks of life can be man aged conservatively and if kept reduced with a block of sponge rubber held in place with tape the hernial ring will become both relatively and actually smaller until the ring closes usually by the 10th or 12th month Unless the child be comes sensitive to the rubber the author pre fers the block of sponge rubber to other pres sure devices because of its even pressure when compressed and because the retaining strip of tape is less tightly applied it will stay in place longer without injury to the skin The mother should be impressed with the importance of keeping the hernia continuously reduced not just applying the sponge rubber and tape occa sionally The simple device of changing the direction of the tape occasionally and painting the skin with compound tincture of benzoin usually obviates any serious irritation of the skin Many small umbilical hernial rings close spontaneously without any treatment but the sponge rubber compression bandage is easy to apply and is reassuring to the mother If an umbilical hernia is present either with or with out compression treatment after one year of age it should be repaired surgically at a suitable time The author prefers to wait until after three years of age unless the hernia is symptomatic in which event it is repaired promptly In our experience the compression treatment is worth less after one year of age

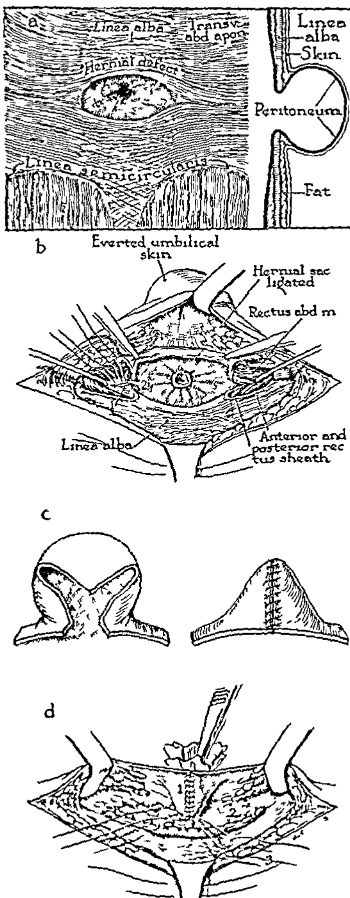
The skin incision which follows the lines of skin cleavage is exactly transverse at umbilical level and may be placed either above or below the umbilicus, depending upon the relationship of the aponeurotic defect to the umbilical protrusion The incision is therefore placed as near the aperture in the linea alba as possible without crossing the umbilical skin and whether it is above or below the umbilical dimple is imma terial One must bear in mind the possibility of an adjacent and coexistent epigastric hernia The umbilical skin is carefully preserved and in the skin closure is used to reproduce a normal appearing umbilicus While the umbilical dim ple is admittedly an unnecessary feature of our anatomy and has no esthetic value its absence will be readily noted by other children and may become a basis for derogatory comments and questions In the adult this is not usually a consideration but even so it is a nicety of the surgeon s art to fashion a normal appearing umbilicus

In children these hernias are usually reduced with ease and the peritoneal sac ligated with out enlarging the hernial ring but if this is necessary the linea alba is incised on either side in the transverse plane After ligation of the neck of the sac the defect is simply closed by a series of interrupted mattress sutures (Fig c) The reconstruction of the umbilical dimple and clos ure of the subcutaneous fascia and skin are as illustrated and described (Fig d)

LARGE UMBILICAL HERNIA

The large umbilical hernia seen in the adult is usually considered to be acquired but certainly there is a congenital predisposition in that there is a weakness of the umbilical scar They are most commonly seen in the obese multiparous female and yet in the author s se ries the serious complication of strangulation has been most common in the elderly debili tated male Whereas incarcerated contents are rare in childhood these hernias in the adult usually contain an irreducible segment of omentum that is densely adherent to the dome

Plate VII Large Umbilical Hernia



a Posterior view of the abdominal wall in a case of large umbilical hernia with the peritoneum and prepentoneal connective tissue removed to demonstrate the large defect in the linea alba which also *extends* on *either* side into the rectus sheath. It also demonstrates the transverse direction of the transversus abdominis aponeurotic fibers and the decussation of aponeurotic fibers from either side of the transversus abdominis internal oblique and external oblique muscles It is interesting to note that the resultant of the pull of the internal oblique and the external oblique fibers is in the transverse plane Thus the summation of the musculoaponeurotic action of the two oblique muscles and the transversus abdominis muscle is exactly in the transverse plane at umbilical level. This points out very clearly why these hernial defects should be closed in the transverse plane and in general why a vertical incision either in the linea alba or the rectus sheath is anatomically and physiologically unsound

On the right is a midline sagittal section through the umbilical hernia to again demonstrate the relationship of the layers

b The hernia repair The hernial sac has been ligated and excised The anterior and posterior rectus sheaths have been incised on either side for two reasons First, it may be necessary to do this for reduction of incarcerated contents but in any event it facilitates the dissection and ligation of the hernial sac second it is difficult to close a rigid ring of this size without gaining mobility and this is done in exactly the same manner as previously illustrated for the large epigastric hernia After incising the posterior rectus sheath transversely as at (1) the posterior rectus sheath of the superior flap is incised vertically on either side as at (2) Mattress sutures placed in the transverse incision in the posterior rectus sheath on either side as demonstrated at (1) *on the left side of the figure* are tied to foreshorten the posterior rectus sheath The rectus muscles are allowed to resume their normal position and the first layer of mattress sutures with alternating single loop sutures are placed exactly as illustrated in (Fig b) for the closure of a large epigastric hernia

c Shows a method of removing the dome of the umbilical skin in a large umbilical hernia which in addition to being excessive is frequently nonviable after it is dissected off of the hernial sac. The margins that are left are then sutured together as shown, to form an umbilical *dimple of* normal size The sutures placed as demonstrated in the everted umbilical skin are then available for removal in the postoperative period when the umbilicus is in the inverted position as shown at (1) in the next figure

d. The hernia repair completed Demonstrates the completed hernia repair (2) for the large umbilical hernia, the details of which have been *previously* illustrated for the large epigastric hernia. The reconstructed umbilicus has been inverted at (1) and the packing is inserted with the forceps The apex of the umbilical skin is *sutured to the* aponeurosis of the overlapping flap as *demonstrated at* (3) with interrupted fine silk sutures The subcutaneous fascia is carefully closed to obliterate deadspace about the umbilicus and the skin closed in the *usual manner* but *in this instance* the periumbilical subcutaneous space is drained

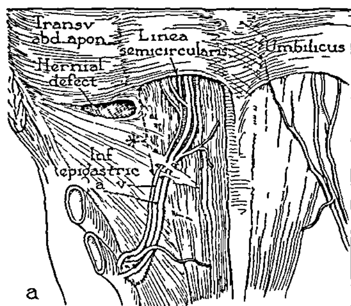
of the peritoneal sac The skin of the umbilicus is always discolored and shows the changes secondary to decreased blood supply The skin incision for this hernia is the same as for the small infantile umbilical hernia and is either above or below the umbilicus, whichever is the more expedient The umbilical skin is carefully dissected off the hernial sac even though much of it may be excised in the reconstruction of the umbilicus

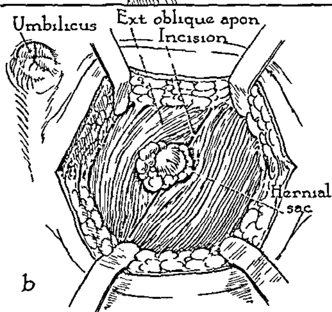
If there is any question of strangulation of the hernial contents the sac is opened before the aponeurotic margins of the defect are incised so that they may be inspected for viability It is disconcerting to say the least to have the contents spontaneously reduce if there is any question of viability of a contained loop of bowel and should this occur one must laboriously examine all of the mobile intestine that could possibly have been contained within the hernia This adds considerable time to the operation not to mention the trauma of the procedure Once the contents are found to be viable the hernial ring is enlarged laterally on either side into the rectus sheath retracting the rectus muscles and incising both anterior and posterior sheath preparatory to starting the hernia repair After this is done the peritoneal sac is more easily freed from the aponeurotic margins of the ring and the neck of the sac is more available for incision and reduction of the contents Adherent bowel is of course carefully freed from the sac and reduced however when the omental adhesions are massive it is frequently more expedite to amputate the omentum contained within the sac as no distinct plane of cleavage may be found Mass ligature of the contained omentum should never be done first because it is a crude procedure leaving a large wad of devitalized omentum within the abdominal cavity, and second because a knuckle of transverse colon is frequently found in the center of the omental mass The defect in the peritoneum is closed in the conventional manner with a purse-string suture or it may be easier to simply close it with a continuous suture in a straight line choosing the direction of closure indicated by the available peritoneum

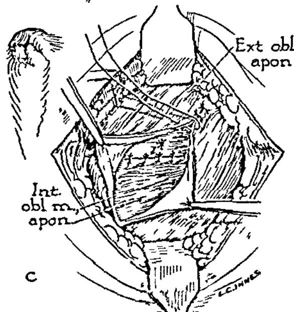
The hernioplasty for the large umbilical hernia is exactly the same as for the large epigastric hernia which is shown in more detail under that heading The transverse and vertical incisions in the posterior rectus sheath are shown (Fig b) and the final closure (Fig d 2) In these large umbilical hernias there is usually a diastasis recti and some umbilical hernias with a neck of intermediate size may be closed by overlapping the linea alba and without entering the rectus sheaths for the more extensive and plastic closure The procedure advisable in any individual case will have to be evaluated on the operating table after the sac has been excised and the peritoneum closed The determining feature is whether the linea alba can be adequately closed without tension

After the hernioplasty an umbilicus is fashioned from the skin of the everted umbilicus which covered the dome of the hernial sac (Fig b) Whereas saving the skin and inverting it is a simple procedure in the small umbilical hernia the fashioning of a normal appearing umbilicus from the stretched out atrophic and frequently avascular skin of the large umbilical hernia is a more complicated process Obviously if the patient is a poor risk the added time involved of saving the skin in the first place and of making an umbilical dimple in the second place would be poor judgment, and the author excises the umbilical skin with the ellipsoidal segment of skin and subcutaneous tissue at the beginning of the operation However when the time permits, the author takes subtle pleasure in reconstructing an umbilicus This possibly picayunish procedure can be accomplished in several ways one of which is demonstrated (Fig c) By the time one is ready to close the skin it is usually apparent that the central segment of the old umbilical skin is not viable and also that the circumference of the dilated umbilicus is too great A pack is placed in the vault of umbilical skin to reconstruct the hernial bulge and an ellipsoidal segment of the skin is excised including a portion of the ring (Fig c), making certain that the margins of excision are viable The edges are then sutured together with interrupted fine silk sutures (Fig c) and the new umbilicus inverted (Fig d 1)

Plate VIII Hernia in the Linea Semilunaris (Spiegel's Hernia)







By definition this spontaneous type of hernia occurs in the linea semilunaris but must be above the point at which the inferior epigastric vessels cross it, otherwise it must be termed a direct inguinal hernia While hernias are recorded along this line above the level of the linea semicircularis they usually occur just below the point where the linea semicircularis intersects the linea semilunaris This is a potential weak point because the *aponeurotic fibers of the* transversus abdominis are changing from the posterior to the anterior rectus sheath This uncommon type of hernia is usually difficult to diagnose in its early interstitial stage and especially in the obese patient It begins in a manner similar to the epigastric hernia with a protrusion of preperitoneal fat which in turn pulls through the attached parietal peritoneum It may be that a perforating blood vessel is a contributing factor It may remain interstitial beneath the external oblique aponeurosis for a long time but if not corrected eventually protrudes through the external oblique aponeurosis where it may be felt and has all the characteristics of a hernia The neck is invariably narrow and strangulation of the contents is a real danger

a Posterior view of the aponeurotic defect in a case of left semilunar or so-called Spiegel's hernia The peritoneum and preperitoneal connective tissue have been removed to show the anatomic relationships of the aponeurotic structures concerned The bracket labeled with the asterisk indicates *the most common distribution of hernias in the* linea semilunaris If the hernia is below the inferior epigastric vessels it is through Hesselbach's triangle and is therefore a direct inguinal hernia

b Anterior view of the left semilunar hernia presenting through the external oblique aponeurosis The exposure is through a transverse skin incision In the author's limited experience with this type of hernia there is a considerable amount of fat surrounding the peritoneal sac which bears out the lipoma theory of origin of this hernia. An incision is made in the external oblique aponeurosis both above and below the hernia (heavy line) and this layer retracted to expose the neck of the hernia as it comes through the transversus abdominis and internal oblique aponeuroses. The peritoneal sac is disposed of in the conventional manner and the fat simply pushed in unless there are pedunculated processes in which event the bases are ligated and the lobules excised There are always blood vessels in the fatty lobules

c The Hernia Repair The peritoneal sac has been removed and the aponeurotic defect closed (asterisk) At this level of the abdominal wall and below the aponeurotic fibers of the transversus abdominis and internal oblique layers closely parallel each other usually have started to decussate and so are handled as a single layer with closure by interrupted fine silk sutures (asterisk) The external oblique aponeurosis is then closed with the same sutures as indicated in the upper angle of the wound. The closure of the layers in this type of hernia is identical with the closure of the muscle splitting appendectomy incision Although this type of hernia may be difficult to diagnose in the early stages it is one of the easiest to repair because there is no significant disruption of the normal musculoaponeurotic mechanism. There should never be a recurrence

Hernias of the Inguinal and Femoral Region

IN THE ENTIRE history of surgery no subject has been so controversial as the repair of groin hernias The inguinal hernia problem has been so hopelessly confused in the past 50 years by such an enormous number of operations that one can only conclude that the proponents of most of these operations did not understand either the normal anatomy of the inguinofemoral region or the pathologic anatomy of hernias It is little wonder that the young surgeon is lost in the maze of contradictory opinion and so he usually mimics his preceptor and eventually adds a twist or two of his own so that instead of the 76 operations known to the author for inguinal and femoral hernioplasty there are probably thousands Certainly the underlying fault is inadequate and frequently inaccurate knowledge of the normal anatomy of the inguinal region

It is small wonder that there is misunderstanding and confusion when our textbooks of anatomy perpetuate such artefacts as the conjoined tendon the falx inguinalis as labeled in anterior views of the inguinal region and the interfoveolar ligament A sharp arching border of the "conjoined tendon" is a product of the dissector s knife and not of normal anatomy The inguinal ligament cannot be seen in posterior views of the inguinal region unless the transversus abdominis layer (posterior inguinal wall) is removed and yet this is a commonly used figure in anatomic discussions of the inguinal region The inguinal ligament should be taken for what it is simply the lower free edge of the external oblique aponeurosis and not an anchoring structure to which everything in the vicinity should be sutured It is embedded in its own fascia which is continuous with the fascia lata and other structures in this region have only a contiguous relationship

Before the reader begins the study of this series on inguinal and femoral hernioplasty he should carefully study the anatomic plate on the following page for one cannot hope to understand the problems involved in these hernias without a thorough understanding of the anatomy as it is here presented While some groin hernias may be technically very difficult to repair because of obesity or the scarring secondary to the injection treatment or to previous operations in general these hernias are simple to repair if one understands the altered anatomy in the various types of groin hernias and the steps necessary to reconstruct a normal inguinal wall In this atlas every effort has been made to simplify the defect and the repair of these hernias and so a constant pattern of presentation is used First the anatomic defect as seen from behind in the cadaver is presented as this is the only way that the true character of the hernial ring can be shown with the mutual relationships of important adjacent structures It is also the only way that the posterior inguinal wall (the transversus abdominis aponeurosis and fused transversalis fascia) can be viewed in its entirety with the important attachments to Cooper s ligament and the femoral sheath In each type of hernia an identical view of the posterior inguinal wall is presented for orientation The next figure in each series then shows the appearance of the hernia as seen in the anterior view at the operating table and then the successive steps in the repair of this defect

Reduced to its simplest form hernioplasty for the small indirect inguinal hernia requires only the removal of the congenital peritoneal sac and closure of the dilated abdominal inguinal ring designated "ABDOMINAL INGUINAL RING REPAIR The large indirect inguinal hernia, the direct inguinal hernia and the femoral hernia all represent destruction of the posterior inguinal wall in varying degrees and from different approaches The problem of the hernioplasty is the same and a single operation is used for these three hernias or any combination of groin hernias designated "RECONSTRUCTION OF THE POSTERIOR INGUINAL WALL"

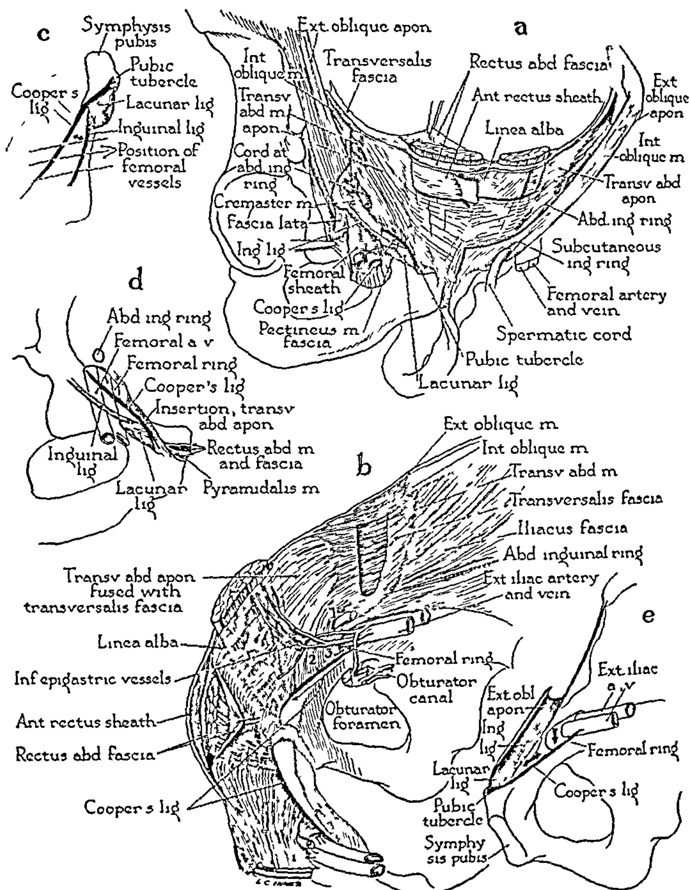


Plate IX The Anatomy of the Inguinofemoral Region

a. Anterior view of the lower abdominal wall dissected to show primarily the right transversus abdominis muscle and aponeurosis *in the region of inguinal and femoral hernia*. Important layers are labeled and the bony pelvis is indicated in outline for better orientation. *Special attention should be directed to the insertion of the lower part of the transversus abdominis aponeurosis into Cooper's ligament and that lateral to this the transversalis fascia continues*

into the thigh as the anterior layer of the femoral sheath. It should be noted that the inguinal ligament is nothing more than the lower free edge of the external oblique aponeurosis and that the lacunar ligament is nothing more than the insertion of this lower edge of the external oblique aponeurosis into the pubic tubercle and the medial end of Cooper's ligament. It is particularly important to understand the anatomic relationships in the small area around Cooper's ligament as illustrated and shown in more detail and from different angles (Figs c d and e) To avoid confusion only two fascial layers are shown, the innermost known as the transversalis fascia and the outermost known as the innominate fascia which is the covering of the external oblique muscle and aponeurosis and it continues into the thigh as the fascia lata Along the upper cut edge of the figure the transversalis fascia can be dissected free as a sheet from the transversus abdominis muscle and aponeurosis and this has been done to show that this fascial layer continues medially to invest the rectus abdominis muscle and become known regionally as the rectus fascia. This fascial continuity becomes of surgical significance after the relaxing incision is made because it is this fascia along *with the rectus muscle that prevents the development* of a hernia through the relaxing incision Lower down in the inguinal region where direct inguinal hernias occur the transversalis fascia is usually inseparably fused to the aponeurosis of the transversus abdominis and from a practical surgical standpoint, the transversus abdominis aponeurosis and its investing fasciae form a single layer

b Posterior view of the lower abdominal wall with the specimen tilted to emphasize the right inguinal region The peritoneum and all of the preperitoneal connective tissue have been removed A window of the transversalis fascia has been removed to more clearly illustrate it as a definite fascial layer In this posterior view it should be especially noted, as was pointed out in the anterior view that the lower portion of the transversus abdominis aponeurosis inserts into Cooper's ligament. The breadth of this insertion is indicated by the bracket, and while there is some normal variation in the breadth of this insertion, it is always much *narrower in a case of femoral hernia because of the* enlarged femoral ring Along the cut edge of the left side of the figure, the medial continuation of the transversalis fascia as the rectus fascia is again demonstrated. Indirect inguinal, direct inguinal and femoral hernias occur in such a small area that it is especially important to understand their anatomic interrelationships An indirect inguinal hernia is the congenital persistence of a processus vaginalis through the abdominal inguinal ring at (1) A direct inguinal hernia is an acquired defect through the aponeurosis of the transversus abdominis (posterior inguinal wall) at (2) A femoral hernia passes through the femoral ring and down the femoral canal at (3) As the indirect inguinal hernia enlarges it pushes more and more of the transversus abdominis aponeurosis (posterior inguinal wall) out around the hernial sac until in the very large variety of this type of hernia, the transversus abdominis aponeurosis in the inguinal region is completely destroyed and the medial margin of the abdominal inguinal ring rests against the lateral border of the rectus abdominis muscle When this situation exists the inguinal canal loses its obliquity and the hernial sac passes directly through the abdominal wall as in the case of a direct inguinal hernia. As the femoral ring enlarges with the contained femoral hernia its medial margin expands medially toward the figure (2) and stops only when the rigid insertion of the inguinal ligament known as the lacunar ligament is reached. It should be apparent that in the small indirect inguinal hernia there is no alteration in the normal anatomy of the musculoaponeurotic layers of the inguinal region The only aberration is the presence of a congenital diverticulum of peritoneum which enters the inguinal canal at the abdominal inguinal ring and if the hernia is repaired before there is any significant dilatation of the abdominal ring the only operation necessary is to remove the peritoneal sac and tighten *the very slight dilatation of the abdominal inguinal ring* Additional plication of layers or sutures placed between the so-called conjoined tendon and the inguinal ligament only serve to open the avenue for a direct inguinal herniation by the very trauma of passing needle and suture through an intact and anatomically normal transversus abdominis aponeurosis

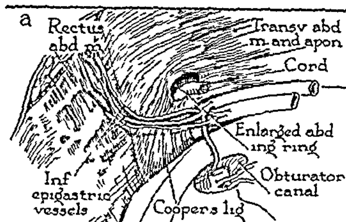
c View of the superior pubic ramus looking directly down upon the bone with Cooper's ligament, the inguinal ligament and the lacunar ligament drawn in to show their anatomic positions and mutual relations The femoral vessels are dotted in for orientation. The arrow indicates the *distance between Cooper's ligament and the inguinal ligament* in this projection.

d. The projection is the same as in figure (a) except that all of the musculoaponeurotic layers have been cut away except for the attachment of the transversus abdominis aponeurosis to Cooper's ligament and its medial continuation over the tendons of origin of the pyramidalis and rectus abdominis muscles and thence down upon the body of the pubic bone The relative positions of the abdominal inguinal ring and the femoral ring are indicated. Again the mutual relations of the inguinal ligament, the lacunar ligament and Cooper's ligament should be noted in this anterior view especially the distance between the medial border of the femoral ring and the lacunar ligament.

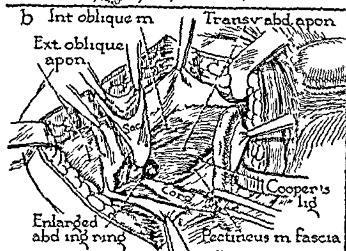
e Posterior view of the pubic bone and attached ligaments—the projection is the same as in the detailed figure (b) The "shelving" border of the inguinal ligament is illustrated in this view because of its popular nomenclature *and especially to again show the interrelationship* of the three ligaments The horizontal arrow above Cooper's ligament is inserted to emphasize the distance between the medial margin of the femoral ring which is the lateralmost attachment of the transversus abdominis aponeurosis into Cooper's ligament, and the lacunar ligament. When a femoral hernia exists and the femoral ring is enlarged medially then the medial margin of the femoral ring lies adjacent to the lacunar ligament and the space represented by the arrow is obliterated. The vertical arrow is inserted to emphasize the distance between the inguinal ligament and Cooper's ligament immediately medial to the femoral vein.

Cooper's ligament (ligamentum pubicum superius) is a very dense composite structure lying along the medial portion of the iliopectineal line and very strongly adherent to the pubic bone. It is made up of periosteum, the insertion of the transversus abdominis aponeurosis and the transversalis fascia, the pectineus fascia and some fibers of origin of the pectineus muscle and medially by the insertion of the inguinal ligament, regionally known as the lacunar ligament. Not shown in these figures and contributing in widely varying amounts are the falx inguinalis which is a lateral expansion of the rectus abdominis tendon of origin and the adminiculum lineae albae which are aberrant laterally expanding fibers from the linea alba.

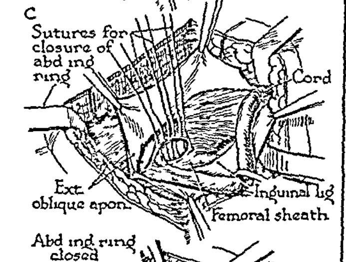
Plate X Small Indirect Inguinal Hernia



a. Posterior view of the right inguinal region with the peritoneum and prepentoneal connective tissue removed. There is no alteration of the normal anatomy *except for very* slight dilatation of the abdominal inguinal ring Since the peritoneum has been removed there is no hernial sac, which sharply outlines the aponeuroticofascial margins of the *abdominal inguinal ring* After removal of the peritoneal sac, the surgical correction of the existing fault consists of pushing the spermatic cord laterally and approximating the upper margin of the ring which is transversalis fascia and transversus abdominis aponeurotic fibers to the lower margin which is femoral sheath.



b *Anterior view of the right inguinal region as seen by the surgeon at the operating table (In this and subsequent operations for inguinal and femoral hernias the drawings have been made with the artist standing at the side of the patient in the position of the surgeon and for uniformity right sided hernias only are presented It is hoped that the presentation of inguinal and femoral hernioplasty in this projection will help to better orientate the surgeon and make the transition from anatomic plate to the operating table easier)* The peritoneal sac has been dissected free from the cord structures well above the fascial margins of the abdominal inguinal ring and ligated *Attenuated transversalis fascia and internal spermatic fascia have been excised to* sharply delineate the aponeuroticofascial margins of the slightly enlarged abdominal inguinal ring It should be noted that the posterior inguinal wall (transversus abdominis aponeurosis) is intact in the area of direct inguinal herniation and that there is a normal breadth of insertion into Cooper s ligament. Both the femoral ring and the integrity of the posterior inguinal wall were checked intra peritoneally by the surgeon s finger prior to ligation of the sac.



c. The sac has been excised and 0000 silk mattress sutures placed for closure of *the dilated abdominal inguinal* ring The lateral component of the lateralmost suture can be seen to pick up small bites of the fascia of the cord. This is done to prevent sliding of the cord within the reconstructed abdominal inguinal ring.



d. The Hernia Repair (Abdominal Inguinal Ring Repair.) The sutures are tied and cut. This closure re-establishes the normal anatomy by approximating the transversalis fascia to the anterior layer of the femoral sheath. The closure of the abdominal inguinal ring is made *just tight enough to fit snugly about the components of the cord* and *the end of the surgeon s fifth finger The spermatic cord is* then dropped back into its normal position against the posterior inguinal wall and the external oblique aponeurosis closed over it making a similarly snug closure of the subcutaneous inguinal ring.

To further aid the reader in his orientation all of the groin hernias in the following series are right sided and beginning with figure (b) in each instance the figures correspond with the surgeons view at the operating table In other words, the head of the patient is to the readers left and the feet to the right

Over a seven year period on the author s service 562 groin hernias have been repaired with an overall recurrence rate of 0 6% This represents all types of inguinal and femoral hernias including recurrent hernias and in this group the operations were performed by 12 dif ferent surgeons including interns and residents

Small Indirect Inguinal Hernia

The small indirect inguinal hernia accounts for between 60% and 70% of all groin hernias which adequately expresses the importance of its proper repair The term small refers only to the diameter of the neck of the sac at the ab dominal inguinal ring and not to the length or the size of the hernial sac Whether the sac is short and confined to the inguinal canal or long and of the so called complete congenital type is of little consequence for the primary considera tion is the dilitation of the abdominal inguinal ring The cure of this type of hernia consists simply of high ligation and excision of the peri toneal sac, and reduction of the aponeurotico fascial abdominal inguinal ring to normal size Any of the "standard operations that plicate the layers or suture "conjoined tendon" to the inguinal ligament are not only unnecessary but the suture holes placed in the posterior inguinal wall may well be the cause of a recurrence as a direct inguinal hernia As long as the posterior inguinal wall is intact it should be left strictly alone and of course its attachment to Cooper s ligament is not disturbed

Preparatory to removing the peritoneal sac from the spermatic cord the spermatic cord is elevated from its bed by incising the very deli cate cremaster fascia along the upper border of the cord While this is not necessary for the re-pair of the hernia it is important to carefully examine the consistency and continuity of the posterior inguinal wall which cannot be done with the cord in place After the posterior wall is exposed the sac is opened and a finger passed into the abdominal cavity and then by a com-bination of palpation from within and inspec tion from without the status of the posterior in-guinal wall can be accurately determined At the same time the femoral ring is felt, to be sure that there is not a coexistent femoral hernia or lipoma of preperitoneal fat in the femoral canal

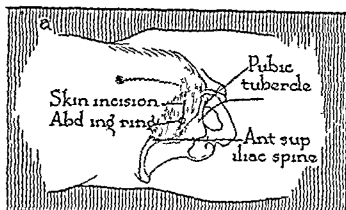
Most surgeons expect the posterior inguinal wall to be a dense aponeuroticofascial structure and when it is thin they feel that they must re enforce it with the more superficial internal oblique and external oblique layers The pos terior inguinal wall is rarely a heavy aponeu-roticofascial plate on the contrary it is usually thin and may even be translucent The impor-tant consideration is that it is intact and that it remains undamaged during the operation Re-tractors should never be placed against it nor should it be handled with instruments

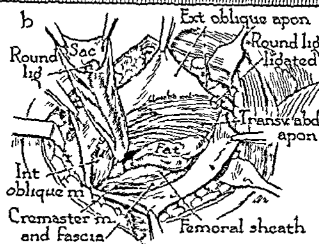
While high ligation of the peritoneal sac is universally recognized as the most important single step in the operation for an indirect in-guinal hernia this does not mean the same thing to all surgeons To the author, high ligation means separating the peritoneum well up through the fascial abdominal inguinal ring pulling the peritoneum up medially from un der the epigastric vessels until the lateral edge of the urinary bladder is seen and after the sac is ligated and the excess excised to see the stump retract at least 2 cms from the fascial margins of the ring The stump is never fixed to the overlying musculature

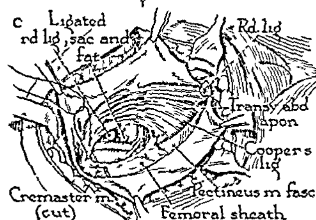
After the sac is disposed of a little sharp dis section at the medial margin of the abdominal inguinal ring will demonstrate the continuity of the transversalis fascia with the anterior layer of the femoral sheath (Fig b) This involves incising the internal spermatic fascia as it starts out onto the cord which is of course the same fascial layer as the transversalis fascia The cord structures are pushed laterally and the ring closed by suturing the transversalis fascia to the anterior layer of the femoral sheath until the ring is reduced to normal size (Figs c and d) Normal size is considered a ring that just ac commodates the cord structures and the tip of the surgeon s fifth finger The external sper matic vessels frequently do not come through the abdominal inguinal ring but through a sep-

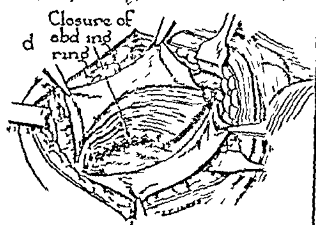
Plate XI

Medium Indirect Inguinal Hernia (Female)









a Position of the skin incision used in the repair of all inguinal and femoral hernias It is placed in the lines of skin cleavage and is situated at the level of the abdominal inguinal ring The abdominal inguinal ring is projected on the skin by taking one-half the distance along a line drawn between the anterior superior iliac spine and the pubic tubercle The incision extends from a vertical line projected upward from the pubic tubercle lateralward for 1 or 2 cms beyond the abdominal inguinal ring This incision is adequate for the repair of all indirect inguinal, direct inguinal and femoral hernias irrespective of size. It heals with a fine linear scar that is almost imperceptible after a year s time The more conventional oblique incision fre quently leaves an unsightly scar

b Anterior view of a small indirect inguinal hernia in a female The round ligament is routinely cut at the pubic tubercle ligating it distally because of the contained blood vessels Then the peritoneal sac and closely adherent round ligament are dissected free from the cremaster muscle and fascia well above the fascial margins of the abdominal in guinal ring and ligated as shown. A pedunculated protrusion of preperitoneal fat is shown which comes through the abdominal inguinal ring with the peritoneal sac. This is also ligated at its base and excised These pedunculated masses of preperitoneal fat are frequently seen associated with an indirect inguinal hernia and it is very important that they be discovered and removed for they can be the entering wedge for the recurrence of a hernia There may be one or as many as five in number and furthermore un less they are removed a tight closure of the ring is im possible

c The peritoneal sac and the pedunculated fatty pad have been excised. The attenuated fasciae that encased the hernial sac have also been excised which leaves the en larged abdominal inguinal ring with a sharp strong mar gin. The insertion of the transversus abdominis aponeurosis (posterior inguinal wall) into Cooper s ligament is normal in breadth ruling out a coexistent femoral hernia and the posterior inguinal wall is everywhere intact so that direct inguinal herniation is not a consideration At the lateral angle of the ring the first mattress suture has been placed which will approximate the transversalis fascia to the anterior femoral sheath The attachment of both the transversus abdominis aponeurosis and the pectineus fascia to Cooper s ligament is clearly shown in this figure. The cremaster muscle is usually left in place but is resected in this figure to more clearly show the femoral sheath.

d The Hernia Repair (Abdominal Inguinal Ring Repair) The mattress sutures which re-establish normal anatomy by approximating the transversalis fascia to the anterior layer of the femoral sheath have been placed and tied Because the inguinal portion of the round ligament has been removed with the peritoneal sac the abdominal inguinal ring is completely closed It is the opinion of the author and of his gynecologic consultant s that the cutting of a round ligament is of no consequence as regards support of the uterus. The removal of the structure that passes through the abdominal inguinal ring makes for a very simple type of hernia repair the layers are easily identified and this type of hernioplasty is ideal for the young surgeon who is just beginning to tussle with the enigma of the hernia problem.

arate aperture medial to the cord The author usually doubly ligates these vessels, cuts them and includes this little foramen in the closure of the abdominal inguinal ring The lateral limb of the lateralmost mattress suture, or a separate single loop suture fixes the cord fasciae to the transversalis fascia to prevent preperitoneal fat from sliding through the ring which could be the entering wedge for another hernia through the abdominal inguinal ring

This concludes the operation for the small indirect inguinal hernia The cord is dropped in against the posterior inguinal wall and the external oblique aponeurosis closed over it making a snug subcutaneous inguinal ring This restores the important normal obliquity of the inguinal canal

Medium Indirect Inguinal Hernia

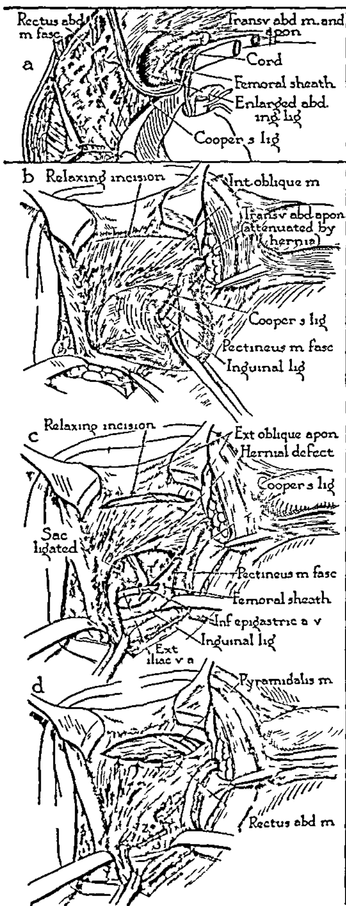
The posterior view of the inguinal region is essentially the same as for the small indirect inguinal hernia and is not repeated In its place a diagrammatic figure is presented to demonstrate the incision that is used for all inguinal and femoral hernias irrespective of size The location of this incision and its extent are described in the legend It is shorter than the classical oblique incision but because of its placement it is adequate and because it follows the lines of skin cleavage it gives a superior cosmetic result The upper portion of the usual incision that bisects the angle formed by the linea semilunaris and the inguinal ligament is beyond the field of operation but necessary for adequate mobilization of the skin flaps

This indirect inguinal hernia in the female is presented for several reasons first it permits a demonstration of the closure of the abdominal inguinal ring unencumbered by the spermatic cord passing through it second it demonstrates the management of a pedunculated process of preperitoneal fat and connective tissue and third, it shows a dilated abdominal inguinal ring that is the upper limit of size that can still be closed by the simple technique of "Abdominal Inguinal Ring Repair"

Since the loss of support of the round ligament does not adversely affect the patient or the support of the uterus removing it with the peritoneal sac greatly simplifies the closure of the abdominal inguinal ring and makes for a nice anatomic demonstration of the continuity of the transversalis fascia into the anterior layer of the femoral sheath It is an ideal teaching case for the beginner in hernia surgery If one attempts to save the round ligament it is frequently difficult to avoid tearing the peritoneum as it is reflected over the round ligament and still obtain a high ligation of the sac One usually ends up with a defect in the side of the sac formerly occupied by the round ligament that is similar to a sac from which a sliding hernia has been removed While leaving the round ligament is technically feasible it is an unnecessarily complicated maneuver when the simple expedient of removing the round ligament with the sac is an alternative

This series also gives the author the opportunity to show a pedunculated process of preperitoneal connective tissue and fat that accompanies the peritoneal sac down into the inguinal canal These fatty protrusions are very common in indirect inguinal hernias in both sexes may be multiple may be the presenting part and form the bulk of the hernia are confusing to the uninitiated and unless they are removed prevent adequate closure of the abdominal inguinal ring Furthermore if they are left in place they can be the entering wedge for the recurrence of a hernia through the abdominal inguinal ring

The dilated abdominal inguinal ring as shown in this series (Fig c) is intermediate between the designations of small and large indirect inguinal hernia and is the upper limit of size that can still be repaired by simple closure of the abdominal inguinal ring (Abdominal Inguinal Ring Repair") It also shows the direction in which an enlarging abdominal inguinal ring expands Compare the size of the defect in (Fig c) with (Fig c) in the preceding plate and (Fig c) in the following plate As long as the expanding abdominal inguinal ring does not extend over into the area of direct inguinal hernia and attenuate the transversus abdominis aponeurotic fibers that insert into Cooper s ligament, the defect which is the enlarged abdominal inguinal ring can still be repaired by the procedure of "Abdominal Inguinal Ring Repair" (Fig d)



a Posterior view of the right inguinal region in a case of large indirect inguinal hernia The peritoneum and the preperitoneal connective tissue have been removed to show the all important aponeuroticofascial defect. If the hernia were larger the inferior epigastric vessels would be pushed even farther medially and would lie behind the rectus abdominis muscle Also in the very large variety of this type of hernia the medial margin of the abdominal ring would abut against the lateral margin of the rectus abdominus muscle From this figure and projecting even further enlargement of the abdominal inguinal ring it should be apparent that the large indirect inguinal hernia destroys the posterior inguinal wall just as effectively as a large direct inguinal hernia

b Anterior view of the right inguinal region in a case of large indirect inguinal hernia The enlarged spermatic cord due to the contained hernial sac and hypertrophied musculofascial layers is retracted to show the bulging dilated abdominal inguinal ring which extends over into the region of direct inguinal herniation. The transversus abdominis aponeurosis and underlying transversalis fascia which surrounded the normal abdominal inguinal ring have been attenuated and pushed out to form the fascial investment of the base of the cord The solid line marked by the asterisk indicates the incision that is made to excise the thinned out portion of the posterior inguinal wall. It begins at the abdominal inguinal ring and ends at Cooper's ligament and should leave a strong margin of transversus abdominis aponeurosis and fascia superiorly which is to be used in the repair of the hernia In this hernia the incision ends at about the midpoint of Cooper s ligament but in the very large variety of indirect inguinal hernia it ends at the pubic tubercle because the entirety of the posterior inguinal wall has been destroyed The dotted line labeled "relaxing incision" shows the point in the rectus sheath that is incised to gain mobility of the new posterior inguinal wall. With the external oblique aponeurosis retracted this incision is made just off center from the mid line and extends from the body of the pubic bone superiorly for a distance of 4 to 6 cms depending upon the size of the defect to be repaired It is usually necessary to incise the accessory slip or sheath that encases the pyramidalis muscle to obtain free sliding of the sheath. In 3% of patients the wall will not slide because of the direct insertion of transversus abdominis aponeurotic fibers into the lateral margin of the rectus abdominis muscle

c. The incision outlined by the solid line in the above figure has been made and all attenuated aponeurosis and fascia excised The margin of the anterior femoral sheath is clearly delineated from the abdominal inguinal ring to Cooper's ligament and the latter cleaned of the attached and fragmented posterior inguinal wall. The peritoneal sac has been dissected free from the cord structures ligated as high as possible and excised Although the dissection of the peritoneal sac is begun before the weakened posterior wall is excised its final dissection is postponed until the attenuated fasciae of the posterior wall are excised and in this way a much higher ligation can be obtained because of the additional exposure The relaxing incision has been made along the dotted line indicated in the above figure

d. The Hernia Repair (Reconstruction of the Posterior Inguinal Wall) The new and strong margin of the transversus abdominis aponeurosis with fused trans

LARGE INDIRECT INGUINAL HERNIA

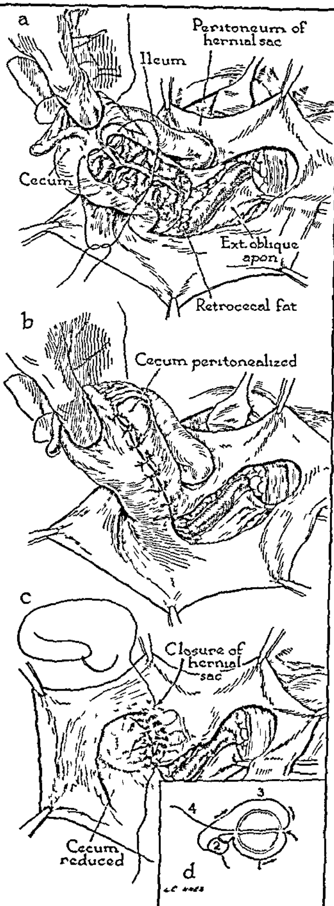
The large indirect inguinal hernia, especially in the obese patient, is usually the most difficult of all the groin hernias for the surgeon to evaluate and the preparation of the layers for the repair of the defect is equally difficult The musculofascial layers of the cord are greatly hypertrophied preperitoneal fatty protrusions accompanying the sac are common and a sliding hernia is a frequent complication to the management of the peritoneal sac Unless the surgeon knows how to deal with this great wad of tissue that fills the abdominal inguinal ring the inguinal canal and extends into the scrotum, the repair of the hernia is impossible This hernia lacks the simplicity of the small indirect inguinal hernia and the sharp definition of layers that characterize the direct inguinal and the femoral hernia It is not necessary to reduce the size of the cord mass beyond the margins of the subcutaneous inguinal ring and frequently it is advisable to leave fragments of the peritoneal sac in the scrotum rather than to traumatize the vascular fascial layers in an attempt to completely remove the sac However along the course of the inguinal canal and through the abdominal inguinal ring it is absolutely necessary to reduce the size of the spermatic cord to normal limits for a tight and secure closure of the abdominal inguinal ring This is accomplished by the usual removal of the peritoneal sac, all preperitoneal connective tissue and fat that has pushed out around the sac, and by excising most of the hypertrophied fascia and cremaster muscle If a varicocele is present it is also excised

It greatly facilitates the dissection of the base of the sac if the incision along the line marked with the asterisk (Fig b) is made before the sac is dissected away from the fascial layers of the cord preparatory to its ligation This incision begins at the superior lateral edge of the abdominal inguinal ring and following the margin of the greatly dilated ring incises the junction between strong posterior inguinal wall and that which has been attenuated and pushed out around the hernial sac With this maneuver of course one has entered the preperitoneal space and by a combination of sharp and blunt dissection the under surface of the remaining posterior inguinal wall is freed of adherent fat and connective tissue The under surface of the posterior wall is the transversalis fascia which is adherent loosely to the transversus abdominis muscle and densely to the aponeurosis The incision extends medially and inferiorly in a curving line to Coopers ligament (Figs b and c) In a hernia of this size the medial portion of the posterior inguinal wall is not disturbed if it is sufficiently strong and intact (Figs a, b and c)

After disposing of the sac and trimming the spermatic cord down to appropriate size the

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versalis fascia is first sutured to Coopers ligament at (1) The sutures placed approximately 2 mms apart, begin at the point where the undamaged posterior inguinal wall attaches to Coopers ligament and end 3 or 4 mms from the wall of the femoral vein These sutures are all placed before any of them are tied because it is easier to place the sutures through Coopers ligament with the exposure afforded in the figure above After they are all placed they are then tied beginning medially and progressing toward the femoral vein The next suture at (2) is called the "transition suture" because it makes the transition from the deeply placed Coopers ligament to the more superficially placed anterior femoral sheath. It approximates the transversus layer to the medial side of the femoral sheath but because this is usually a very thin layer it also picks up the fascia of the pectineus muscle This suture is necessary not only to restore normal anatomic continuity but to avoid leaving an aperture through which preperitoneal fat can protrude and lay the ground work for the beginning of a recurrent hernia The transversus layer is then sutured to the anterior layer of the femoral sheath at (3) until the abdominal inguinal ring is snugly closed as described in the closure of the abdominal inguinal ring in the small indirect inguinal hernia If the transversus layer at this level is aponeurotic the full thickness of the layer is of course used but if it is muscular then only the underlying transversalis fascia is sutured to the femoral sheath After the repair is complete it will be noted that the relaxing incision which was formerly only a slit is now a roughly triangular defect through which the rectus and pyramidalis muscles can plainly be seen. The size of the defect in the rectus sheath where the relaxing incision was made is directly proportional to the size of the hernial defect. The author has never seen a hernia that was too large to repair by this method of sliding the rectus sheath into the position of the posterior inguinal wall. The lateral edge of the relaxing incision is sutured to the underlying rectus abdominis muscle only when the latter is tendonous When it is muscular the edge is left to lie free against the muscle The spermatic cord is then dropped in against the reconstructed posterior inguinal wall and the external oblique aponeurosis closed over it making a snug subcutaneous inguinal ring



Because a sliding hernia is so frequently encountered in the large indirect inguinal hernia this plate is presented. The management of the sliding hernia is simple if one understands the mechanism of its occurrence. Although the *gradual transition* of a small indirect inguinal hernial sac into a large scrotal sac is in part due to the stretching of the pre-existing sac, *it is due in greater measure to the* pulling down or sliding of parietal peritoneum into the hernia In those instances when the cecum is a fixed viscus without a mesentery or the sigmoid colon has a very short mesentery it is easy to see how these viscera become a portion of the wall of the hernial sac After the peritoneum of the sac is incised as shown (Fig a) the viscus must be freed in the *avascular prepentoneal layer adjacent to the* mesentery or the mesenteric vessels will be damaged with resultant serious hemorrhage The surgeon who does a very high ligation of the sac will see more sliding hernias than is generally indicated

a Sliding hernia of the cecum in a case of right indirect inguinal hernia. The cecum and its visceral peritoneum actually form the inferolateral wall of the hernial sac To reduce the cecum and not incorporate it in the ligature of the hernial sac it must of course be freed from the sac of the hernia This is accomplished by a horseshoe shaped in*cision which follows the line of reflection of the peritoneum* of the sac up onto the cecum. The open end of the horseshoe embraces the ascending colon within the fascial margins of the abdominal inguinal ring The first suture in the peritonization of the cecum is placed

b Shows the peritonization of the cecum completed by *interrupted fine silk sutures* and the defect in the hernial sac formerly occupied by the cecum

c *Shows* the cecum reduced into the peritoneal cavity The purse string suture is started and will be continued *around the circumference of the neck* of the hernial sac This is not considered the final closure of the peritoneum but simply a means of gathering the margins of the neck of the sac together for as high a ligation as possible. The purse string suture invariably leaves folds of peritoneum *through which omentum or a portion of a* hollow viscus could protrude and additional ligature of the sac is necessary by one of several methods Simple encirclement of the pursed peritoneum would suffice if the ligature would not slip off A sure method of additional ligation which will not slip is shown in the inset (Fig d)

d The author's method of secure ligation of the hernial sac After the purse string suture has been tied, the *limb of* the suture threaded with the needle is taken around the sac 180° at (1) *and passed through the* base of the sac just distal to the purse-string suture and tied at (2) It is then taken around the sac 180° in the opposite direction at (3) and the base of the sac again transfixed. After this the end of the suture at (4) is again tied and the peritoneum of the sac *distal to the tie is excised.* A popular method of handling such a sac is to twist it repeatedly and then suture-ligature the base While this is a rapid method of dealing with the sac there is danger of catching omentum or bowel as the sac is progressively twisted.

ragged edge of the anterior femoral sheath is trimmed to a sharp clean margin (Fig c) from the abdominal inguinal ring to Coopers ligament In the process the femoral vein and artery are carefully located but not exposed as figured The inferior epigastric vessels, unless injured, usually cause no trouble but may be doubly ligated and cut if it facilitates the dissection of the sac A small artery and vein to the pyramidalis muscle course along Cooper s ligament and these are routinely cut between ligatures to avoid tearing them when suturing to Cooper s ligament Aberrant obturator vessels are frequently present arising either from the external iliac or the inferior epigastric vessels and if troublesome should be cut between ligatures As mentioned earlier the external spermatic vessels are usually divided because they prevent tight closure of the abdominal inguinal ring

When the stage in the operation is reached where the sac has been tied and the spermatic cord reduced in size, the margins of the posterior inguinal wall Cooper s ligament and the femoral sheath sharply delineated and the relaxing incision made (Fig c) the hernioplasty is quite simply accomplished by suturing the posterior inguinal wall to its normal attachments (Fig d) as described in the legend While placing the sutures and until they are all tied the preperitoneal fat must be pushed inward for clear visibility This is accomplished by a small gauze pack and a narrow ribbon retractor introduced obliquely from the lateral aspect of the wound The handle of a long tissue forceps makes an ideal retractor for this purpose The sliding effect which permits the transfer of anterior rectus sheath into the position of a new posterior inguinal wall is readily apparent by comparing figures (c) and (d) Before the slide the relaxing incision is a mere slit in the rectus sheath (Fig c) and after the slide it is a defect which varies in size directly with the size of the inguinal defect If the rectus fascia is not disturbed there is no danger of a hernia developing in this defect in the rectus sheath The rectus fascia is the medial continuation of the transversalis fascia which invests the rectus muscle This fascial plane is easily inspected by carefully elevating the lateral edge of the relaxing incision and separating the rectus sheath lateralward to the lateral edge of the rectus muscle

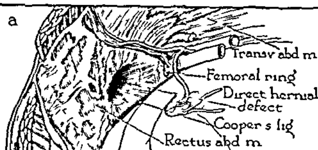
The normal obliquity of the inguinal canal is restored by dropping the spermatic cord in against the new posterior inguinal wall and closing the external oblique aponeurosis over it with a snug closure of the subcutaneous inguinal ring

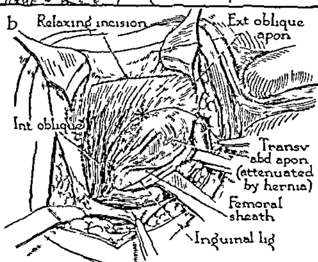
Direct Inguinal Hernia

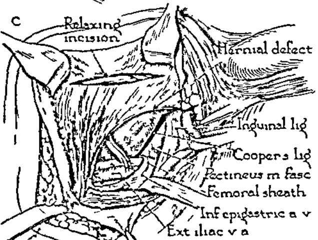
A direct inguinal hernia is fundamentally different from either the indirect inguinal or the femoral hernia in that it does not protrude through a naturally occurring aponeuroticofascial aperture While the predisposition to a direct inguinal hernia may be congenital in the sense that there is a generalized weakness of connective tissue these hernias are acquired and consist of a gradual stretching and attenuation of the posterior inguinal wall With the exception of the funicular type of direct inguinal hernia with a narrow neck and a small aperture through an otherwise intact posterior inguinal wall these hernias have a broad base with a wide neck and a relatively short sac Unless the sac is long and contrary to the usual opinion they may extend into the scrotum the direct inguinal hernia rarely strangulates (the funicular type excepted) Many middle aged or elderly individuals are seen with either unilateral or bilateral small pouting types of direct inguinal hernias that cause no symptoms Unless this type of hernia is enlarging and the patient is physically active hernioplasty is meddlesome surgery because it exposes the patient to the morbidity and mortality of an operation that is unnecessary Furthermore when these hernias appear in the elderly and seem to cause symptoms the search for a cause of increased intra abdominal pressure (such as prostatism, partial colon obstruction and chronic cough) and its correction is a more rational approach than hernioplasty

A direct inguinal hernia is a breach through the posterior inguinal wall and irrespective of its size demands "Reconstruction of the Posterior Inguinal Wall" The details of the op-

Plate XIV Direct Inguinal Hernia









a Posterior view of the right inguinal region in a case of direct inguinal hernia The peritoneum and the preperitoneal connective tissue have been removed to show the aponeuroticofascial defect and its relationship to the important anatomic landmarks of the posterior inguinal wall It should be noted that the abdominal inguinal ring and the femoral ring are normal in size and are in no way concerned with the development of a direct inguinal hernia The size of the hernial ring in this case is only moderate and is purposely chosen rather than a very large direct inguinal hernia so that its relationship to the regions of the other groin hernias may be carefully observed

b Anterior view of the right inguinal region in a case of direct inguinal hernia The bulge of the hernia is covered by attenuated transversus abdominis aponeurosis and transversalis fascia and as the hernia enlarges this posterior inguinal wall becomes progressively thinner In this case the spermatic cord is normal in size and there is no associated indirect inguinal hernia nor is there a coexistant femoral hernia The problem is to remove the thinned out aponeuroticofascial components of the posterior inguinal wall (transversus abdominis aponeurosis and fascia) and substitute a strong layer to repair the defect. The solid line marked by the asterisk follows the junction of strong posterior inguinal wall and attenuated posterior inguinal wall produced by the hernia It begins at the abdominal inguinal ring and extends to Cooper s ligament near the pubic tubercle The dotted line represents the relaxing incision in the rectus sheath and its exact location is described in the preceding hernia.

c The incision outlined by the solid line in the above figure has been made and all of the attenuated aponeurosis and fascia excised down to Cooper s ligament and the anterior layer of the femoral sheath Care should be exercised that small vessels along Cooper s ligament, aberrant obturator vessels and the cluster of vessels arising from the external iliac artery and vein are not inadvertently torn. They may all be ligated if necessary to adequately expose Cooper s ligament and the femoral sheath but the bleeding that ensues following their accidental injury can be very troublesome When there is dense scarring along this line from previous surgery or the injection treatment of the hernia it is expedient to ligate these vessels at their origins from the iliac vessels and again distally rather than try to dissect them out of scar tissue Both Cooper s ligament and the anterior femoral sheath must be sharply delineated and clean to adequately repair the hernia It cannot be blindly done by pushing the bulge of the hernia back and then trying to suture "conjoined tendon" to Cooper s ligament. In this case the neck of the hernial sac is broad and there is no question of incarcerated contents the sac is therefore not opened but simply pushed back into the abdomen. If the direct hernia is of the pedunculated type with a narrow neck then the sac must be opened and treated as an indirect hernial sac to avoid leaving incarcerated or even strangulated contents If the sac is not opened especial care must be taken to rule out a concomitant small indirect inguinal hernia and even though there is no peritoneal diverticulum of a femoral hernia one frequently sees a pedunculated projection of preperitoneal fat in the femoral canal. This should be removed as it is the precursor of a femoral hernia The relaxing incision has been made along the line indicated in the figure above

eration are shown in the accompanying figures and legends and it should be noted that the repair of this type of hernia is essentially the same as for the large indirect inguinal variety except that the new posterior inguinal wall is sutured to the entire length of Cooper s liga ment from pubic tubercle to femoral vein This is necessary because the hernia has destroyed the wall up to the lateral margin of the rectus muscle and slides out over the superior ramus of the pubic bone from pubic tubercle to fem oral vein (Figs a, b and c) In the case of the small type of indirect inguinal hernia it has been mentioned that the suturing of "conjoined tendon" to inguinal ligament is unnecessary as well as meddlesome In the large indirect in guinal hernia and in the direct inguinal hernia the use of the inguinal ligament as the anchor ing structure for the posterior inguinal wall is an anatomic mistake as can be seen from con sulting the figures on the Anatomic Plate and opposite (Fig c) Except for attachment of the inguinal ligament (locally called the lacunar ligament) along the medial 1 cm of Cooper s ligament the two structures gradually become more divergent in a lateral direction While sutures placed through the lacunar portion of the inguinal ligament are in effect also attached to Cooper s ligament this is not true for the remainder of the inguinal ligament which is a free margin It is not the insertion of the pos terior inguinal wall (see Anatomic Plate) nor is it a suitable substitute The fact that it has been used for 60 years and the statements to the effect that it is more available than Cooper s ligament or that suturing to Cooper s ligament is more difficult are not valid arguments against the suturing of the posterior inguinal wall to its normal insertion, which is Cooper s ligament Reconstruction of the posterior inguinal wall is a technically easy procedure (except in the obese) if the surgeon is anatomically oriented as the author has demonstrated many times in the training of interns and residents The opera- tion is an enigma to the surgeon whose ana tomic knowledge is based solely on the inguinal ligament herniorrhaphies

Irrespective of the size of a direct inguinal hernia or the number of recurrences the rectus sheath between the relaxing incision and the margin of the hernial defect (Figs b and c) is invariably intact and there is sufficient aponeu rosis to slide into the defect for reconstruction of the posterior inguinal wall The author has never had to resort to fascial transplants or the use of wire mesh in the repair of inguinal or femoral hernias

After resecting the aponeurosis and fascia thinned out by the hernia delineating the strong superior edge of the posterior inguinal wall, clearing Cooper s ligament and the anterior fem oral sheath and making the relaxing incision the hernioplasty of reconstruction of the pos terior inguinal wall is accomplished (Fig d) Before the closure is started one must make ab- solutely certain that there is not a coexistent in direct hernial sac This is easily determined by the exploring finger if the direct hernial sac has been opened but as in most instances where the peritoneal bulge is simply pushed inward a small congenital indirect sac may be overlooked The structures at the abdominal inguinal ring are carefully inspected for a diverticulum of peritoneum and incidentally for protrusions of preperitoneal fat in among the cord structures Because of the excellent exposure of the region

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d. The Hernia Repair (Reconstruction of the Pos terior Inguinal Wall) The cut margin of the trans versus abdominis aponeurosis and fused transversalis fascia is first sutured to Cooper s ligament at (1) beginning at the pubic tubercle and continuing laterally to within 3 or 4 mms of the medial wall of the femoral vein All of these sutures are placed before tying any of them for technical reasons described before The next suture at (2) is the "transition" suture which approximates the transversus aponeurosis and fascia to the medial wall of the femoral sheath and the pectineus fascia The transversus layer is then sutured to the anterior layer of the femoral sheath at (3) until the abdominal inguinal ring is snugly closed

As in the preceding hernia there is now a triangular de fect where the relaxing incision was made It should be realized that the aponeurosis used to repair the inguinal wall defect is rectus sheath (transverse abdominis and in ternal oblique aponeurosis) that has been shifted laterally and inferiorly The defect left by this shift is protected from herniation by the underlying rectus muscle and its enveloping rectus fascia which is continuous laterally with the transversalis fascia This figure completes the operation and all that remains to be done is to drop the spermatic cord in against the newly constructed posterior inguinal wall and close the external oblique aponeurosis over it, making a snug subcutaneous inguinal ring

of the femoral nng ıt ıs easy to rule out a fem oral hernıa, but unless the femoral veın ıs vısualızed one may mıss a fatty protrusıon down ınto the femoral canal If such a protru sıon of prepentoneal fat ıs left ın place, suturır the postenor ınguınal wall to Cooper s lıgamei wıll not close the femoral nng and the precurs of a femoral hernıa ıs left ın place

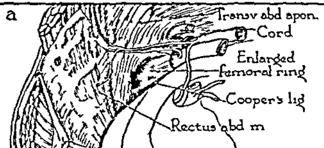
Femoral Hernia

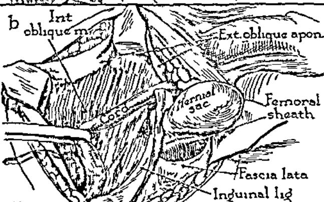
OF ALL THE groin hernias, the femoral hernia lends itself best to a demonstration of the anatomic relationships of the layers in the inguinal region and their attachments The abdominal inguinal ring is normal and one can observe the transition of the transversalis fascia into the anterior layer of the femoral sheath without the distortion that is present in an indirect inguinal hernia The surgeon should take advantage of this opportunity to inspect the normal abdominal inguinal ring, for the pliability of the fascia and muscle in the living subject is in sharp contrast to the rigidity and fixation of the ring in the cadaver The appearance of the abdominal inguinal ring in its normal state should of course be the pattern for the "ABDOMINAL INGUINAL RING REPAIR used in all small to medium sized indirect inguinal hernias The importance of being able to fashion an anatomically correct abdominal inguinal ring is apparent when one considers the relative frequency of the indirect inguinal hernia The transversus abdominis aponeurosis and its fasciae as they form the posterior inguinal wall furnish the surgeon another opportunity to examine normal anatomic structure in the absence of distortion by herniation Invariably the posterior inguinal wall is strong in the area of direct herniation when a femoral hernia is present

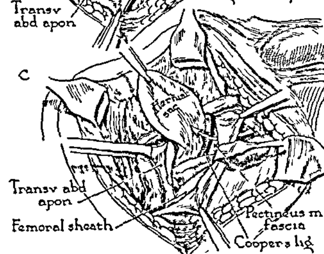
Although the mass of a femoral hernia is palpable and visible in the femoral region hence the terminology it is in fact another variety of inguinal hernia The anatomic fault that permits a femoral hernia to develop is as truly inguinal in location as that of either the direct or indirect inguinal variety (Fig a) One should again consult the Anatomic Plate (Fig b) that precedes the presentation of inguinal hernias and note the numbers 1 2 and 3 which represent respectively the sites of origin of the indirect inguinal hernia the direct inguinal hernia and the femoral hernia These three hernias are all breaches in the posterior inguinal wall but at different locations and due to different mechanisms The indirect type is due to the congenital persistence of the processus vaginalis the direct type to an acquired defect in the posterior inguinal wall and the femoral hernia to a narrowing of the insertion of the posterior inguinal wall into Coopers ligament This concept of the interrelationship of the three hernias is very important in a consideration of the proper repair of the defect

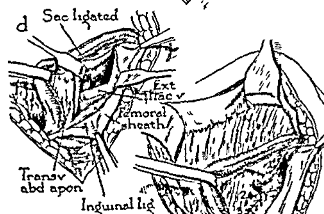
Whether the etiology of a femoral hernia is congenital in origin due to a narrow insertion of the transversus abdominis aponeurosis (posterior inguinal wall) into Coopers ligament with a correspondingly broader femoral ring or whether it is an acquired hernia and the insertion is secondarily narrowed by pressure of the developing hernia the author has never been able to settle It is perfectly true that it is not congenital in the sense that there is a preformed sac yet there is considerable normal variation in the breadth of the insertion of the posterior inguinal wall into Coopers ligament with a correspondingly inverse variation in the transverse diameter of the femoral ring Irrespective of the underlying etiology the important point is that the correction of the defect in a femoral hernia is to broaden the insertion of the posterior inguinal wall into Coopers ligament so that the femoral ring is closed The anatomy texts state that the medial margin of the femoral ring is the lacunar ligament and it may be this inaccuracy that accounts for the failure of many surgeons to understand the proper repair of this hernia While it is perfectly true that in a case of femoral hernia the medial margin of the constricting ring lies against the lacunar ligament this is a pathologic state It is also true that the lacunar and inguinal ligaments when stretched by a femoral hernia limit the size of the ring and contribute to the rigidity of the ring but they are part of a secondary and more superficial ring as can be nicely demonstrated when the inguinal ligament must be

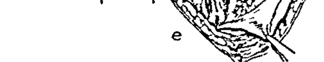
Plate XV Femoral Hernia











a Posterior view of the right inguinal region in a case of femoral hernia. The peritoneum and the preperitoneal connective tissue have been removed to show the aponeurot icofascial defect in this type of hernia The abdominal inguinal ring is normal in size and the main area of direct inguinal herniation is intact however the enlarged femoral ring has encroached upon the base of the posterior inguinal wall The important anatomic defect in this type of hernia is that the insertion of the transversus abdominis aponeurosis into Cooper s ligament is greatly narrowed, and conversely the correction of this type of hernia is to broaden this inser tion to normal width and obliterate the femoral ring The femoral hernial defect is always of constant size It cannot enlarge laterally because of the femoral vessels nor inferior ly because of the superior ramus of the pubic bone covered by Cooper s ligament. It enlarges medially until the more superficially placed lacunar ligament is encountered and may enlarge slightly anteriorly pushing the inguinal liga ment until it becomes taut. The fully developed femoral hernia has an unyielding aponeurotic and bony ring which makes this type of hernia so frequently strangulating in char acter

b Anterior view of the right inguinofemoral region in a case of femoral hernia. The inguinal region is entirely nor mal except for a slight bulge over the neck of the hernial sac and a broadening of the femoral sheath. The cord has been elevated to reveal the lower inguinal region and to give access to the neck of the femoral hernia The skin and subcutaneous fascia of the lower skin flap are retracted to show the fossa ovalis and expose the femoral hernial sac. As demonstrated in the figure above the anatomic defect in a femoral hernia is a narrowing of the insertion of the posterior inguinal wall (transversus abdominis aponeurosis) into Cooper s ligament by the enlargement of the femoral ring which surrounds the neck of the femoral hernia To reduce the hernia and repair this defect the only satisfac tory approach is through the inguinal region Since there is no weakness of the posterior inguinal wall as seen in a direct inguinal hernia and no enlargement of the abdominal inguinal ring as seen in an indirect inguinal hernia one is not con cerned with an indirect inguinal hernial sac or with weakness or attenuation of the transversus abdominis aponeurosis To expose the neck of the hernia an incision is made along the dotted line indicated by the asterisk The incision begins me-dially at the insertion of the transversus abdominis aponeu rosis into Cooper s ligament and then comes up over the bulge of the neck of the hernia and is continued laterally over the femoral vessels along the line where transversalis fascia be-comes anterior femoral sheath. This opens into the pre-peritoneal space and exposes the femoral vein, neck of the hernia and Cooper s ligament.

c The incision of the posterior inguinal wall and fem oral sheath has been opened and the femoral hernia has been pulled out of the femoral region into the position of a direct inguinal hernial sac (white arrow) In small fem-oral hernias this maneuver is usually accomplished with ease but if the hernia is of the size indicated in the drawing, or if there is much edema, it can not be reduced without releasing the tightly constricting aponeuroticofascial ring

cut to release a femoral hernia The inner constricting ring is the dilated true femoral ring, which is the transversalis fascia at the point where it becomes femoral sheath and re en forced by transversus abdominis aponeurotic fibers of the posterior inguinal wall en route to their insertion into Cooper s ligament (Figs a and b) The normal femoral ring and its mar gins and their relationship to the lacunar ligament can be seen in Figs (a) and (d) of the Anatomic Plate

Since the posterior inguinal wall is the first and only satisfactory bulwark against hernia tion in the groin and since the defect in a fem oral hernia is a narrowing of the insertion of the posterior inguinal wall into Cooper s ligament, the only rational method of repair is to broaden this insertion so as to close the femoral ring (Figs d and e) It should be noted that the final result in the repair of the large indirect and the direct inguinal hernia is essentially the same as in a case of femoral hernia Compare the last figure in each plate Since the greater portion of the posterior inguinal wall is not disturbed in a femoral hernia the relaxing incision is usually not necessary to accomplish closure without tension and so is omitted If the inguinal ligament is included in the sutures that approximate the posterior inguinal wall to Cooper s ligament, it is not only an unanatomic procedure, but is accomplished only with great tension as is evidenced by the great number of heavy su ture materials that have been recommended in the past for use in femoral hernioplasty

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Cutting into the lacunar ligament medially may sufficiently relieve the constriction to allow reduction but if it does not, the lacunar portion of the inguinal ligament, or the inguinal ligament itself is completely divided with impunity When this maneuver is necessary it is interesting to note that even after cutting the aponeurotic inguinal ligament there is still a constricting band of fascia which must be incised and this is of course the fascia of the femoral sheath. After the hernial sac is in the position of a direct inguinal hernia the sac is opened dissected free from the preperitoneal connective tissue and urinary bladder ligated at its base and excised. Particular care is necessary in opening a fem oral hernial sac because the medial wall of the neck of the sac is invariably urinary bladder

d Shows the normal posterior inguinal wall retracted which reveals the ligated femoral hernial sac, Cooper s liga ment, anterior femoral sheath and the femoral vessels In normal anatomy and in cases of indirect inguinal and direct inguinal hernias the femoral sheath curves around the medial side of the femoral vein to continue the continuity with the posterior femoral sheath. A femoral hernia so at tenuates this medial wall of the femoral sheath that the continuity is lost and it should be noted that the anterior femoral sheath disappears medially under the inguinal liga ment (beneath the retractor) This is noteworthy because the transition suture in this hernioplasty first picks up the pectineus muscle fascia and then the anterior femoral sheath to reconstruct the medial wall of the femoral sheath and closes the angle between the level of the anterior femoral sheath and Cooper s ligament. It should also be noted that the incision does not extend into the abdominal inguinal ring and therefore closure of the abdominal inguinal ring is not necessary in this type of hernia.

e THE HERNIA REPAIR (REATTACHMENT OF THE POSTERIOR INGUINAL WALL) The posterior inguinal wall is sutured to Cooper s ligament along the line of the incision in (b) except that it is carried laterally to within 3 or 4 mms of the femoral vein to close the femoral ring and broaden the insertion of the posterior inguinal wall to nor mal at (1) The transition suture is next placed at (2) and approximates the transversus abdominis aponeurosis to the pectineus muscle fascia and also picks up the anterior fem oral sheath. The remainder of the closure is then ac complished by suturing the transversalis fascia, or the entire transversus layer when it is aponeurotic to the anterior layer of the femoral sheath at (3) This figure shows the operation completed and all that remains to be done is to drop the cord in against the posterior inguinal wall and close the external oblique aponeurosis over it, making a snug subcutaneous inguinal ring A femoral hernioplasty is one of the most satisfying of all hernia operations in the groin because there is no shortage of aponeurosis and usually the posterior inguinal wall *is a heavy aponeuroticofascial layer* The relaxing incision is not necessary

Plate XVI Small Incisional Hernia

a Posterior view of the abdominal wall in a case of right lower quadrant incisional hernia. The incision is the commonly used right rectus incision for appendectomy and was made two years prior to the operation *for the in*cisional hernia In this case the defect is divided into two apertures by a bundle of attenuated but still intact aponeurotic fibers of the transversus abdominis and internal oblique layers This fenestration of incisional hernial defects is a common arrangement and results in multilocular hernial sacs in this case the hernial sac is bilocular (Fig c) Whatever the contributing factors may be such as infection, drain sites or failure of suture material, the basic etiology of an incisional hernia is the inability of the closure to withstand the lateral pull of the transversus abdominis and the oblique muscles The arrow indicates the distance that the transversus abdominis muscle fibers have contracted The clefts lateral to the scar and the hernial defects are elongated suture holes due to the contraction of the muscles *against the unyielding suture material*

b Anterior view of the hernia in the lower pole of the old right rectus scar The dark line indicates the incision that is used with the excision of an ellipsoidal segment of redundant skin over the bulge of the hernia

c. Anterior view of the small incisional hernia with the skin and subcutaneous fascia retracted and the external oblique aponeurosis dissected off the hernia and opened widely in the direction of its fibers This demonstrates the principal aponeurotic defect, which is in the transversus abdominis and internal oblique layers which are fused at this level to constitute the anterior rectus sheath *It is a bilocular* sac because in this case the hernial defect is bridged by a band of intact aponeurotic fibers Between this figure and the next, the two hernial apertures have been converted *into a single defect by excising the dividing band and the hernial sac opened* ligated and excised in the conventional manner Adhesions between the peritoneum of the hernial sac and its contents are invariably present and must be carefully *dissected free* Attenuated aponeurosis and fascia from the margins of the defect are excised back to normal tissue and firm scar in the line of the old incision.

d The Hernia Repair. The hernial defect in the rectus sheath has been closed transversely with interrupted sutures of either fine silk or stainless steel wire *This closure is without tension* whereas if the defect were closed in the vertical plane again, the contracted transversus abdominis and internal oblique layers could *only* be *approximated* under tension. Medially the line of closure extends past the point where the external oblique aponeurosis fuses with the other layers *in the rectus* sheath. In the upper left hand corner the closure of the external oblique aponeurosis has been started and this is continued in the line of the aponeurotic fibers *repairing* the small defect in the medial flap of the external oblique aponeurosis.

Incisional Hernia

An incisional hernia is a type of ventral hernia but is distinguished from other hernias of the abdominal wall by the fact that it occurs through a previous surgical incision It is difficult to ascertain the true incidence of this type of hernia for many reasons but especially because it is difficult to get a long term follow-up on a large series An analysis of the available statistical data reveals an incidence of incisional hernia from 0 5% to 8% and while it is not the province of a surgical atlas to discuss the significance of this wide discrepancy it is axiomatic that the careful surgeon who follows sound principles of surgical technique will have a lower incidence of incisional hernia than the careless surgeon irrespective of the type of incision that is used All other factors being equal which is of course impossible of attainment the incidence of incisional hernia is directly related to the type of incision that is used The advances that have been made in the past 15 years that permit more extensive and radical surgery with safety for the patient, frequently obtain exposure without consideration for the abdominal wall and the eventual fate of the incision While the adequacy of an operation should never be jeopardized by inadequate exposure through an incision that is too small the surgeon should be aware that the longer the incision the greater the incidence of incisional herniation The old aphorism that the length of an incision is of little consequence since a wound heals from side to side and not from end to end is as inaccurate as the premise that the more scar tissue in a wound the stronger the wound After a long fatiguing operation rapid and careless wound closure while expedite will greatly increase the incidence of herniation irrespective of the type of incision that is used Every surgeon is occasionally faced with an emergency in which time is the essence and the speed with which an incision can be made and closed is important for the life of the patient In this instance the greater likelihood of an incisional hernia in a vertical incision is a calculated risk However, in the majority of cases the little additional time involved in making an anatomically sound incision and closing it correctly will reduce the incidence of postoperative wound hernias

Because the problems of incisional hernioplasty are so complex and because at times there is no good solution to the problem the surgeon should so make and close his abdominal incisions that the incidence of incisional hernia is kept at an absolute minimum The small muscle and aponeurosis splitting appendectomy incision that cuts no muscle or aponeurotic fibers is the perfect abdominal incision In the absence of infection and if accurately closed this incision should never result in an incisional hernia However the limited exposure afforded precludes its use for the more major abdominal operations and so a compromise must be made and some aponeurotic or muscle fibers cut The larger abdominal incisions should be made in such a direction that the number of fibers cut is kept at a minimum and with special attention to the direction of the transversus abdominis muscle and aponeurosis (see *Frontispiece*) The integrity of this layer must be maintained or an incisional hernia is certain to develop no matter how solid a closure is accomplished in the internal and external oblique layers Since the direction of the fibers of the transversus abdominis are as the name indicates predominately transverse, all abdominal incisions should be transverse and the musculoaponeurotic fibers of this layer carefully separated without interrupting their continuity A varying number of the internal and external oblique fibers must of necessity be cut and this varies with the position of the incision and its length Incisional hernias occur through these incisions (0 5% in the author s cases) although not as frequently as with the vertical incisions in the rectus sheath When they do occur they are repaired with relative ease

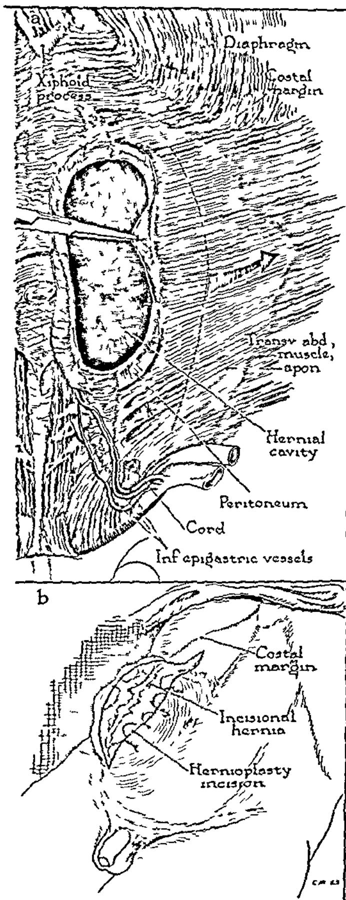


Plate XVII Large Incisional Hernia

a. Posterior view of the right anterior abdominal wall in a case of massive incisional hernia. Most of the long right rectus vertical incision has widely separated. The original incision was a lower right rectus vertical incision for an appendectomy that was extended upward almost to the costal margin to do a cholecystectomy. The peritoneum and preperitoneal connective tissue have been removed except for a cuff around the margins of the hernial defect. The dotted line represents the approximate position of the musculoaponeurotic junction of the transversus abdominis in normal anatomy and the shaded arrow indicates the marked lateral displacement of this junction in this case of large incisional hernia. This represents a true muscle contracture due to the inability of the original closure to keep the cut tendonous fibers in apposition. The asterisks indicate clefts in the aponeurosis similar to those shown in the small incisional hernia. The upper and lower poles of the scar are attenuated but still intact. A hernia of this size presents a problem to which there is no good solution. The defect is too long to approximate in a transverse plane and too wide to reapproximate in the vertical plane because the contracture of the transversus abdominis and oblique muscles is unyielding even under surgical anesthesia.

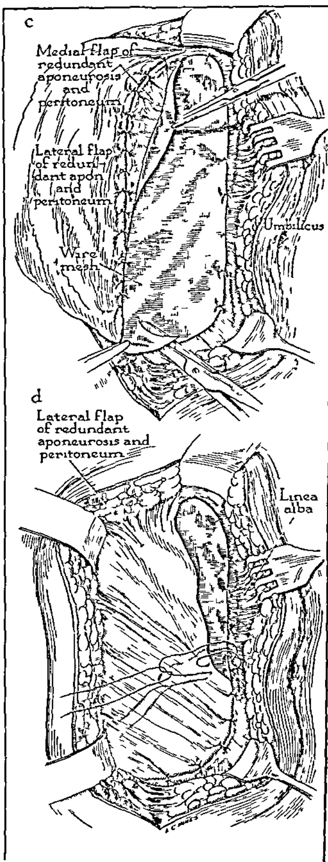
b. Anterior view of the large incisional hernia. Multiple loops of intestine give the surface a nodular appearance since they are covered by little more than atrophic skin and peritoneum. The viscera are invariably densely adherent to the peritoneum of the hernial sac and therefore the sac should be entered with caution or a segment of intestine may be opened. The ellipsoidal skin incision, indicated by the dark lines, excises the atrophic stretched-out skin over the top of the hernial mass. This excision of redundant and atrophic skin is provisional, and additional skin is usually excised when the skin is closed at the conclusion of the operation.

Plate XVIII Large Incisional Hernia

c The Hernia Repair A stage in the closure of the large incisional hernial defect Prior to this stage of the hernioplasty the skin flaps with attached subcutaneous fascia have been developed beyond the margins of the aponeurotic defect and the central portion of atrophic skin excised The hernial sac has been opened vertically for its full length equidistant from the medial and lateral margins of the defect and the constituents of the sac, peritoneum and at tenuated fascia and aponeurosis carefully preserved as a single layer This entails painstaking dissection to release the viscera from the sac and yet not button hole the flaps which must be used in the closure Adherent loops of colon, small intestine and omentum are separated from one another be fore reducing them into the abdominal cavity

At this stage in the hernioplasty the medial flap of fused peritoneum fascia and aponeurosis has been trimmed to fit the hernial defect and sutured to the lateral margin of the aponeurotic defect with interrupted No 30 or No 32 gauge stainless steel wire as indicated in the figure A sheet of stainless steel wire mesh is cut to exactly fit the defect and is sutured in place circumferentially as shown. No attempt is made to decrease the size of the defect by pulling and suturing the flaps under tension as the success of this unanatomic closure depends upon healing without the layers separating at the suture lines

d The Hernia Repair. The last stage in the closure of the incisional hernial defect The lateral flap of redundant and fused aponeurosis fascia and peritoneum has been turned medially and trimmed to exactly fit the defect as was done for the previously sutured medial flap The ap proximation of the edge of this flap to the medial margin of the defect has been partially completed. It should be noted that these sutures are double loop sutures and that they include the edge of the wire mesh as well as the me dial margin of the defect In position they alternate with the previously placed sutures that hold the sheet of wire mesh in place In spite of the most careful hemostasis a wound of this size principally involving scar tissue will have a great deal of capillary bleeding and oozing of serum and therefore must be drained Furthermore the metallic wire mesh acting as a foreign body will increase the amount of serum that is formed and accentuates the necessity for drainage In the author s experience the wire mesh is tol erated better when it is placed between the flaps of the hernial sac rather than in the subcutaneous space as an added layer to the aponeuroticofascial closure An ordinary penrose drain is split lengthwise and one piece of drain left in the space occupied by the wire mesh and the other drains the entire length of the subcutaneous space Both drains are exteriorized through the lower pole of the wound and are gradually removed at the daily dressing so that they are completely removed in a period of six or seven days After this the drain sinus is probed daily until serum ceases to form. The subcutaneous fascia and skin are each closed with a single layer of interrupted fine silk sutures



The great majority of incisions through the abdominal walls of the American people are vertical, transecting both anterior and posterior rectus sheath and therefore most incisional hernias occur in vertical incisions, due primarily to failure of union in the posterior rectus sheath The vertical incision through the rectus sheath or through the linea alba severs all of the tendonous fibers of the three anterolateral abdominal muscles for the length of that incision After closure of the incision and even in the absence of such aggravating factors as abdominal distension, cough and wound infection the contraction of the transversus abdominis and two oblique muscles constantly tends to pull the wound apart The aponeuroses do not lend themselves to accurate approximation in the way that a round tendon does nor is it possible to put the abdominal wound at rest as is the case with tendons of the hand and so there is constant tension along the line of closure with frequent and sudden increases in tension Every surgeon has had the disheartening experience of seeing his needle or suture pull out from between the fibers of the rectus sheath in closing a vertical incision The decussation of the aponeurotic fibers in the sheath plus the adhesive character of the investing fasciae are the two features which prevent this from happening routinely The contraction of the fibers in the posterior rectus sheath when they are separated transversely only tends to bring the margins of the incision in close approximation The force that tends to separate the incision in the anterior rectus sheath is the resultant of the pull of the internal and external oblique fibers severed but when the incision is transverse the pull of the muscles is oblique to the incision and the tension is roughly one half that of the vertical incision In the vertical incision one must not only consider the pull of the muscles on the side of the incision but their counterpart on the opposite side of the abdomen

It is probably true that the rent that permits the incisional hernia to develop occurs in the early postoperative period although it may not become apparent for months or years but additive to this is the gradual stretching of the scar Scar tissue has no elasticity and does not have the strength of collagenous fibers of a tendon or an aponeurosis Slowly and inexorably scar tissue stretches and if this is the only feature upon which the surgeon bases his wound technique there will be a gradual stretching and thinning of the scar Fortunately the process is slow and if no actual rent exists through the posterior rectus sheath most patients live out their life span without a true hernia developing although very thin and bulging vertical scars are common place

As a group, incisional hernias are the most difficult of all hernias to repair surgically They are so varied in size and shape and the availability of good aponeuroticofascial layers is so unpredictable that one can not categorically state that a certain operation should be used for a given hernia and certainly no single operation will cover all types of incisional hernias Each incisional hernia is a problem in itself and the most suitable repair in a given case must be decided at the operating table Incisional hernias tax the ingenuity of the surgeon more than any other type of hernia

It is important for the surgeon to realize that an incisional hernia in a vertical scar represents a retraction of the aponeurotic fibers lateral to the defect and a contracture of the corresponding muscle fibers Whenever possible the defect should be closed along a line parallel with the predominant muscle pull which is almost always in the transverse plane When this is impossible as in a vertically long oval defect and the hernial orifice is closed in the vertical plane again the closure is always under extreme tension and should be re-enforced with an aponeuroticofascial transplant or with wire mesh In the very large defect such as shown in the accompanying figures it is a mechanical impossibility to approximate the margins of the hernial ring and one must resort to a closure by substances other than homologous tissue Various substances that have been used in the past will not be reviewed for the author considers the wire mesh available today to be superior to substances previously used

For this section on incisional hernias only two types of hernias are presented but they represent the extremes In between the small and the

very large incisional hernia shown there is such a variety of aponeuroticofascial deficiency that it is impossible to describe an operation that would be suitable in every instance However if the surgeon follows the basic principles out lined in the foregoing paragraphs has a reason able degree of ingenuity and is thoroughly fa miliar with the anatomy of the abdominal wall a solution to the closure of the defect is usually apparent Whenever possible the layers should be developed individually and closed along the natural lines of musculoaponeurotic stress as outlined for the small incisional hernia shown However, when this is not possible or practical as is frequently the case in the group of moder ate sized defects no attempt is made to free up individual layers they are left in the fused state and handled as a single layer with an overlap ping vest over pants" closure in the transverse plane in a manner similar to the closure of mod erate sized epigastric and umbilical hernias The peritoneum is left attached to the fused and scarred aponeuroticofascial plates without any attempt to accomplish a separate closure of the peritoneum unless it is loose and mobile but this is rarely the case When the hernia does not involve the entirety of the previous incision and it is possible to obtain a transverse closure that portion that is not actually part of the hernial defect is left undisturbed even though the scar may be thinned out and with some diastasis If the defect is a vertical oval and cannot be closed in the transverse axis then all of the old scar is excised prior to closure The reason for leaving an attenuated portion of the scar when the hernial defect can be closed transversely is that the author would prefer to perform a sec ond operation in the future if another hernia develops in the remaining scar and also close the secondary hernia in the transverse plane The reason for avoiding a vertical closure of these defects should be obvious The original incision was vertical the defect represents a retraction and fixed contracture of the transversus abdom inis and oblique muscles lateral to the defect and vertical closure will be under greater ten sion than the original surgical closure The in cidence of recurrent herniation in this group is excessive

Except for the cases in which there is a total separation of the wound in the early postopera tive period with a massive defect most incision al hernias begin as small defects frequently at the site of a drain The right lower quadrant vertical rectus incision is the most common example of this and next in frequency is the *right upper quadrant vertical rectus incision for* cholecystectomy Another common site is the upper end of a suprapubic midline incision in the vicinity of the umbilicus It is probably true that most of these hernias are seen by some physician while they are still small and rela tively asymptomatic but it is factual that most of these hernias are ignored for a long time un til the neck has enlarged and there is consider able mushrooming of the sac in the subcutane ous layer It is easy to understand the reticence of the patient to submit to an operation for such a small relatively asymptomatic defect and the physician may be reluctant to urge prompt re pair especially if the original incision was his However, it is in this stage that these hernias should be operated upon for the problem is relatively simple for the surgeon and a minor procedure for the patient When allowed to develop into the classical incisional hernia with a large rigid defect in the abdomial wall and a large subcutaneous sac not only are they symp tomatic but there is eminent danger of strangu lation Unfortunately it is usually when this stage is reached that the patient seeks relief and the skill of the surgeon is taxed to the limit to fashion a new abdominal wall

The massive incisional hernia shown in the accompanying figures presents a problem to which there is no good solution Irrespective of the substance used to reinforce the closure, whether it be wire mesh or homologous aponeu roticofascial grafts the end result is scar tissue and because it covers such a large area it will inevitably stretch to an alarming degree The patient should never become obese and should at all times wear a firmly supporting abdominal girdle or corset Weight reduction prior to op eration is an absolute prerequisite for the obese and the prognosis should always be guarded One of these large defects closed with the aid

of a sheet of wire mesh may feel very strong and firm in the first months after operation, but this should not lull either patient or surgeon into a feeling of false security, for eventually the wire mesh fragments and the sole support for the wound is the scarred flaps that have been used plus the scar tissue incident to the presence of the wire mesh If the patient is cooperative in the years after such an operation and no discrete aperture appears in the closure, these patients get along satisfactorily with limited physical activity The obdurate patient who gains weight and returns to hard physical labor is doomed to recurrent trouble

In the author s experience, there is less serum drainage and more prompt wound healing if the wire mesh is incorporated in the aponeuroticofascial flaps of the closure rather than adding it to the closure so that the mesh lies in the subcutaneous space This is not always possible, but the attempt should be made to save sufficient covering for the wire mesh from the attenuated aponeuroses of the hernial sac The subcutaneous space as well as the space occupied by the wire mesh should be drained because of the accumulation of serum which always occurs The author uses a penrose drain split lengthwise putting one portion in the subcutaneous space and the other in the space occupied by the wire mesh, exteriorizing both of them at the inferior pole of the wound The wound is first dressed in 24 hours and the drain started out Thereafter the wound is dressed daily and at each dressing the drains are moved so that they are completely out in six or seven days After this the drain site should be probed daily until there is no further accumulation of serum, usually 12 to 14 days In the postoperative management of these patients the abdominal wall should be supported by a scultetus or surgical corset until the wound is healed Before dismissal from the hospital these patients should be fitted with a firm girdle or corset and instructed to wear this support the rest of their life

Lumbar and Pelvic Hernias

LUMBAR HERNIAS are hernias through the lumbar region and they are usually subdivided into superior lumbar hernias through the triangle or rhomboid of Grynfeltt and inferior lumbar hernias through the triangle of Petit There is such descriptive variation in the superior lumbar triangle that no attempt will be made to discuss herniation in this region except to say that the layers should be reconstructed separately and as in hernias elsewhere through the abdominal wall, the reconstruction of the transversus abdominis layer is the most important The inferior lumbar triangle or triangle of Petit is rather constantly present in cadaver dissections and with considerable variation in size but the existence of this triangle is in no way associated with the development of a hernia in this region except of course that the hernia does protrude through the triangle The propensity for the development of an inferior lumbar triangle hernia is predicated upon the deficiency either congenital or acquired of the transversus abdominis and internal oblique layers In the accompanying figure it can be seen that the base of the inferior lumbar triangle of Petit is the posterior iliac crest and the other two sides of the triangle are projected by the dotted lines marked with the asterisk The posterior boundary of the triangle is the anterior border of the latissimus dorsi muscle and the anterior boundary is the posterior border of the external oblique muscle In this specimen although there is a deficiency of the transversus abdominis layer as shown at (†) the more superficial internal oblique muscle is perfectly intact and prevented the development of a lumbar hernia Irrespective of the existence of a lumbar triangle or its size if there is a deficiency of the more deeply placed transversus abdominis and internal oblique layers a lumbar hernia will develop Conversely, if these layers are intact an inferior lumbar triangle hernia will not develop even if a large triangle of Petit is present

PELVIC HERNIAS In the pelvic portion of the figure are two examples of a pelvic hernia These hernias, present in the same specimen had peritoneal sacs but they were small and contained no viscera The peritoneal sacs with a cuff of peritoneum have been left for better orientation In the treatment of these hernias after the sac has been pulled out, the defect must either be plugged firmly with wadded up sac and preperitoneal connective tissue or preferably obliterated by approximating the margins of the defect In the case of an obturator hernia this may be difficult because of the rigidity of the margins of the obturator canal, and in a sciatic hernia great care must be observed lest the superior gluteal vessels be torn or the lumbosacral trunk of the sacral plexus incorporated in the attempted closure Each case of pelvic hernia will have to be individualized at the time of operation and the best procedure chosen Sciatic hernias may also gain egress through the greater sciatic notch below the pyriformis muscle at the location of the stump of the inferior gluteal artery in the figure or through the lesser sciatic notch along with the converging fascicles of the obturator internus muscle

So called internal hernias are primarily a problem of the relief of intestinal obstruction and except for the congenital malrotations of the intestine they present no particular problem from the standpoint of hernia repair and so are not considered in this atlas

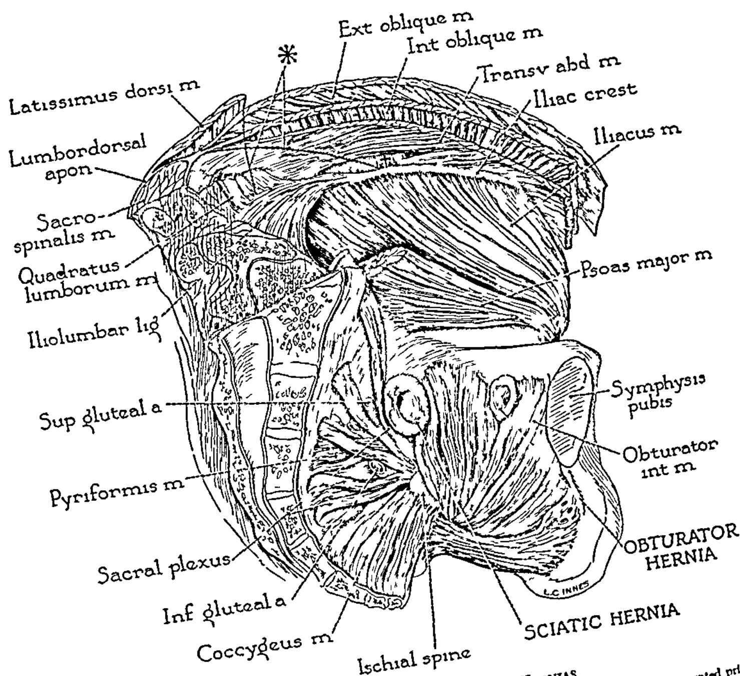


Plate XIX. Lumbar and Pelvic Hernias

Internal view of the left lateral pelvic wall and the lower lumbar area to show the anatomy of the region. Lumbar and pelvic hernias are so infrequently seen and the author's experience with these hernias has been so limited that it is felt that nothing can be added to the documented methods of repairing these hernias. This figure is presented primarily to show the anatomic relationships of these hernias and also because it was an interesting cadaver specimen in which there were both an obturator and a superior gluteal type of sciatic hernia.

This Book

HERNIA *The Pathologic Anatomy of the More Common Hernias and Their Anatomic Repair*

By CHESTER B McVAY, M D Ph.D

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